Compressed Air

A MONTHLY MAGAZINE DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

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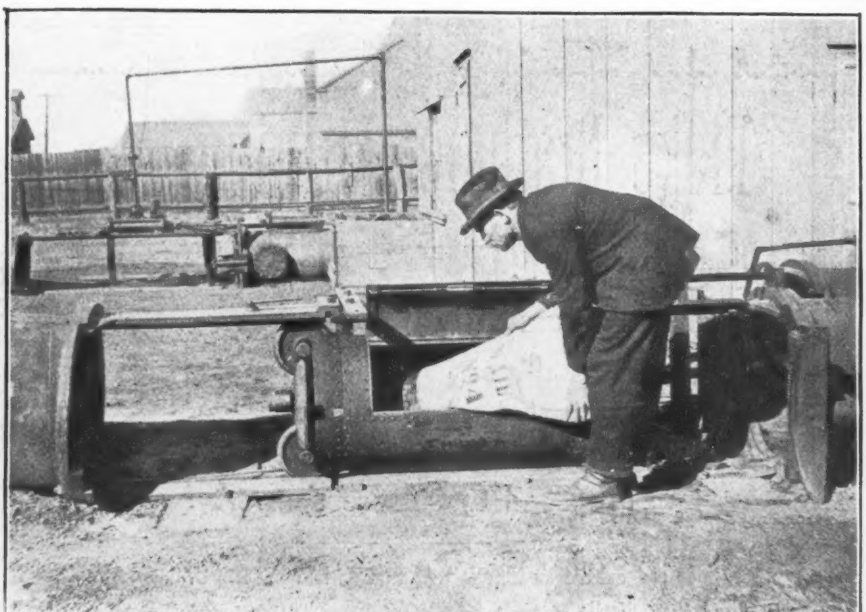

. TUBE 24 INCH DIAMETER

DISPATCHING A MAIL BAG IN THE SYSTEM OF THE UNITED STATES PNEUMATIC DISPATCH CO., BURLINGTON, N. J., U. S A.

Compressed Air.

OR

THE COMPRESSED AIR MAGAZINE.

A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

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The carrying of mail or parcels of any kind through pneumatic tubes is a very old idea. The most common illustrations are the "Petit Bleu" in Paris, a practical system which has been in operation for many years. By this system one may write a telegram or a letter and have it forwarded in a sealed envelope to its destination by passing it through a pneumatic dispatch tube. The purpose of this is to facilitate dispatch, and to a certain extent it takes the place of the telegraph or telephone service. These things are largely matters of custom; people in Paris are accustomed to this way of doing things, while in America we resort to the telephone or we send a telegram or a special delivery letter. Another common illustration of the pneumatic tube is seen in department stores, where packages are transmitted to different parts of the building. These are simple cases, involving few if any difficulties, because the work is done on a small scale. During recent years important advances have been made in the direction of perfecting mechanism by which carriers of large diameters are transported through tubes, and the success and utility of the systems now in use in large cities for doing this are matters that are no longer questioned.

Those who are interested in the investigations being carried on by Congress in pneumatic dispatch systems for the transportation of mails in large cities will perhaps be surprised to learn that in addition to the two systems that have received so much publicity, the Batcheller system and the Bostedo system, another thoroughly equipped system, 2,400 feet in length, at Burlington, N. J., has been drawn to the attention of the Congressional Committee.

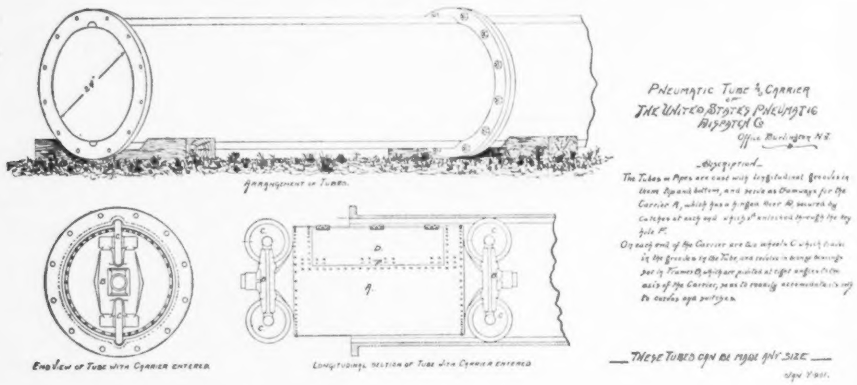
Mr. John McIntyre has recently made some interesting investigations of this new system, and through him we learn that as long ago as 1896 this system, which is owned by The United States Pneumatic Dispatch Company, was thoroughly investigated by a committee formed of men in high position in the government service, who were appointed by Postmaster-General Wm. L. Wilson. That Committee recommended that the system be built between Brooklyn and New York over the Brooklyn Bridge. The Postmaster of New York, Charles Dayton, and the Postmaster of Brooklyn, W. T. Sullivan, heartily supported the report, which Postmaster-General Wilson approved. However, for some reason never explained, another system was built.

The United States Pneumatic Dispatch Co. has not advertised its system, nor has it frequented the Capitol Building at Washington. This company claims for its system many advantages over the Batcheller system, which is now carrying the mails, or rather, a portion of the mails in Philadelphia, New York and Boston, and the Bostedo system, which is now being built in Boston for the light package express business. The Batchel-

ler system carries the mail loose, necessitating it being handled by tube company employees at each end of the system—this would be true of the Bostedo system—whereas the carriers used in the Burlington system accommodate at least three or four of the regulation locked mail pouches filled with mail of any class. For mechanical reasons, and, without certain important changes, it is doubtful if the other systems named could be enlarged to accomplish this important point in the transportation of mails.

The system at Burlington is 2,400 feet long, as has been stated, the pipe being unfinished 24 inches inside diameter, cast with grooves at top and bottom, in which the wheels sustaining the weight of the carrier run. At the terminal stations the carriers run out on rails and therefore do not have to be lifted or carried, as is the case with the Batcheller and Bostedo systems. The carrier is sent through the tube at a speed of 33 miles an hour, with a pressure of 7 ounces. This speed was increased to over 50 miles an hour for the last examining committee. A Connersville blower is used to operate the line. There is a loop of 16 feet radius and several automatic Y's and switches into which the carriers can be guided, thus showing the practicability of diverting the carrier into any sub-post offices or side stations that might be established.

It is not necessary to machine or to bore out tubes used by the United States Pneumatic Dispatch Company. The cost of boring is greater than the cost of the tube itself. The statement made to the Second Assistant Postmaster General by the Pneumatic Tube Investigating Committee under date of December 4th, 1900, shows that a bored tube six inches in internal diameter would cost $1.12½ a foot, and such a tube eight inches in internal diameter would cost $1.50 a foot. The tube used by the United States Pneumatic Dispatch Company, however, would cost for one six inches in internal diameter less than forty-five (45) cents a foot, or one eight inches in internal diameter less than sixty-five (65) cents a foot. At the cost given above for a six-inch bored tube ($1.12½ a foot), one of the tubes of the United States Pneumatic Dispatch Company twelve inches in internal diameter could be furnished, and the latter would have a capacity four times as great as the six-inch bored tube, or at the cost given above for an eight-inch bored tube ($1.50 a foot), one of the tubes of the United States Pneumatic Dispatch Company

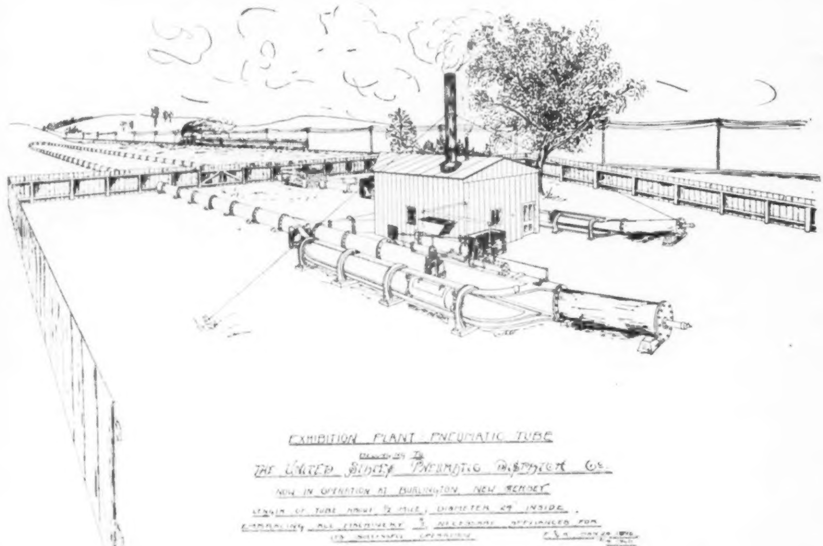


fourteen inches in internal diameter could be furnished having three times the capacity of the eight-inch bored tube. A twenty-four inch tube such as is at the exhibition plant in Burlington would cost less than three dollars ($3.00) a foot.

The cost of operating the United States Pneumatic Dispatch Company's system should be materially less than the bored tube now in use. On the latter it is necessary to maintain a pressure of from three to seven pounds to the square inch, whereas the United States Pneumatic Dispatch Company's carriers can be operated with from five to seven ounces of pressure. It is claimed that with the United States Pneumatic Dispatch Company's system it is possible to transport all the mail of all classes, thus eliminating the cost of wagon service entirely, and to carry all the mail at less cost than is possible with wagons, and that by this system the whole body of the mail may have as rapid dispatch as a small portion, or what might be called supplemental mail.

By this system the mail can be carried in regular pouches, sealed at the dispatching office by regular postal officials, to be delivered in like sealed condition to postal officials at the receiving points.

This is an important point in that the mail when once placed in the bags remains intact, and is not subject to losses due to breaking of bulk, and is therefore less liable to damage either through accident or design. The use of air at low pressure is always an advantage, it being a well-known fact that the cost of compressing air increases directly as the pressure, the volume remaining the same.



The simplicity of the air compressing apparatus is greater for lower than for higher pressures, and its efficiency should also be greater. If it is true, as claimed, that this new system of pneumatic dispatch may use air supplied by a blower, we might reasonably expect economy and in view of the large diameter of the pipe, friction losses are probably reduced to a minimum.

Pumping by Compressed Air.
(CONTINUED)

By E. A. Rix.

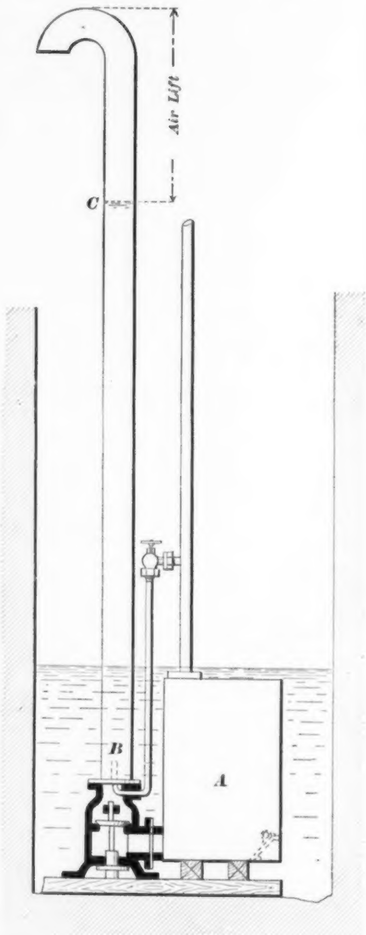
The Wheeler device, Fig. 18, permits the displacement to take place with low pressures, and thus adds to the efficiency. The table marked Fig. 19, accompanies Mr. Behr's report. Test No. 21 shows the best efficiency, viz., 30 per cent. air pressure, 33.75 pounds work done; 4 horse power; water lifted, 1,271 pounds; quantity of air, 7.78 pounds per minute. Comparing this with the results obtained in the discussion of air lift and simple displacement pumps we have: Air pressure, 33.75 pounds—10 per cent. for dynamic head, equals 30 pounds for active pressure. The equivalent head is 70 feet, consequently the water will stand 70 feet in the discharge pipe and the air lift will be 35 feet, giving a submersion of 2 to 1, and air lift pressure of 33.75 pounds.

Referring to the tables of air lift experiments, tables marked Fig. 20 and 21, we find that 2 cubic feet of air to 1 of water will do the work. There was practically 20 cubic feet lifted, making 40 cubic feet of air required at 33.75 pounds pressure, or 4.80 horse power. The displacement of 20 cubic feet of water at 30 pounds required 22 cubic feet of air at 33.75 pounds pressure. Allowing 10 per cent. clearance, which was 72 cubic feet of free air, this, at 12 horse power per 100, equals 8.64 horse power, 8.64+4.80=13.44 horse power, almost identical with results shown in the table. There can be no question but that the economy of this system could be greatly enhanced by using the expansive force of the air that is lost in exhausting from the displacement chambers, and one of the easiest means of doing this is on the principle which I suggested for the multi-stage displacement pump, as illustrated in Fig. 8.

CUMMINGS, OR TWO-PIPE, SYSTEM.

This is a simple system, consisting in compressing the air to a high pressure, say 200 pounds per square inch, the idea being that full-pressure motions are more economical the nearer you approach full pressure. For instance, from 0 to 100 pounds we observe quite an extended compression curve, while from 800 to 900 pounds there would practically be no urve, but simply full pressure work, the part one wishes to utilize in direct acting pumps.

Take the card No. 1, Fig. 22, and it will be noted that the compression area is A, B, C, E only, the area, A, F, G, H, being



A is displacement chamber raising water to C, when air from pipes at B complete the lift.

FIG. 18.

always back pressure. The area of the compression is therefore 8 square inches; the work done is calculated at 70 per

RESULTS OF TEST OF WHEELER PNEUMATIC PUMP.

By H. C. BEHR.

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
					Water, H.P.				Operating.
TEST NUMBER.	Average Air Pressure Above Atmosphere.	Weight of Air Used, Lbs., per Minute.	Weight of Water Pumped, Lbs., per Minute.	Number of Pump Strokes, Approximate, per Minute.	Work Realized, Water Lifted to Height of 105 Feet.	Efficiency Based on Comparison of Work Returned, with Least Work Theoretically Needed for Compression.	Efficiency of Compression in Ordinary Practice.	Total Efficiency Product of Columns VII and VIII, Multiplied by $\frac{85}{100}$ for Efficiency of Compressing Mechanism.	Work Spent. Indicated Work of Stream or Power.
	Lbs. per sq. in	Lbs.	Lbs.	Per Min.	H. P.	Per Cent.	Per Cent.	Per Cent.	H. P.
5	41.000	12.270	1,971	18.00	6.271	42.48	69.4	25.02	25.0
14	39.000	12.050	1,948	18.50	6.198	41.75	70.6	25.05	24.7
13	39.000	9.137	1,481	15.50	4.712	44.00	70.6	26.40	17.8
2	34.500	13.106	1,888	17.00	6.007	41.91	73.3	26.08	23.0
12	34.500	9.079	1,423	15.00	4.528	45.52	73.3	28.36	15.9
21	33.750	7.780	1,271	12.75	4.033	48.09	73.8	30.17	13.3
15	33.500	11.020	1,716	16.25	5.460	46.04	73.9	29.90	18.2
1	33.000	13.687	1,935	18.00	6.158	42.08	74.2	26.53	23.2
6	30.375	5.770	785	8.20	2.497	42.80	75.8	27.40	9.1
3	29.500	13.060	1,668	....	5.309	40.56	76.3	26.30	20.
22	29.250	9.810	1,426	14.50	4.386	44.86	76.5	29.24	15.0
20	29.125	7.650	1,102	11.00	3.506	46.12	76.7	29.90	11.7
4	27.250	13.800	1,633	15.50	5.196	39.33	78.0	26.07	19.9
17	24.125	10.080	1,160	13.00?	3.690	39.84	79.5	29.90	13.7
9	24.125	5.340	730	7.75	2.323	50.15	79.5	33.90	6.8
10	23.750	10.120	1,133	11.00	3.605	40.43	79.8	27.40	13.1
18	19.625	7.390	608	6.00	1.935	33.54	82.2	23.40	8.2
11	19.500	9.397	834	8.25	2.654	36.35	82.3	25.40	10.0
19	19.375	7.600	626	8.50	1.992	33.89	82.4	23.70	8.4
7	19.000	9.780	856	7.80	2,724	36.35	82.6	25.50	10.0
8	14.500	7.140	350	4.00	1.114	24.14	85.0	17.44	6.3

Column Pipe 4 Inch Diameter.
Lift, 105 Feet.

NOTE.—Test No. 16 was thrown out on account of uncertainty of speed counter observation.

FIG. 19.

TABLE OF EXPERIMENTS

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Number of Tests.	No. of Compressor Strokes per Min.	Pressure per Sq. Inch in Receiver.	Weir Head, Inches.	Length of Water Pipe Below Surface of Water. Ft.	Length of Water Pipe Below Surface of Water. Ft.	Temperature in Receiver. Fah.	Temperature of Air in Room Fah.	Temp're of Water at Weir. Fah.	Quantity of Water Pumped per Sec. Cubic Feet.	Weight of Water Pumped per Sec. Lbs.
1	59	31.15	4.1	75.55	55.78	77°	72.6°	68°	.0799	11.25
2	45	27.86	3.8	75.55	55.78	78°	70.7°	68°	.1488	9.3
3	30	25.64	3.	75.55	55.78	79°	74°	68°	.0824	5.15
4	59	30.69	5.2	35.53	55.5	74°	72°	71.6°	.3259	20.37
5	46	26.4	5.1	35.53	55.5	78°	71.6°	68°	.3105	19.41
6	30	24.78	4.6	35.53	55.5	78°	73.2°	68°	.2398	14.99
7	22	24.16	4.25	35.53	55.5	78°	72.5°	68°	.1968	12.3
8	60	24.1	3.85	54.7	36.33	78°	73°	70°	.1538	9.61
9	35	17.58	3.15	54.7	36.33	78°	73°	70°	.0931	5.82
10	22	16.17	2.6	54.45	36.58	74°	74°	69°	.0576	3.6
11	60	20.58	3.2	63.16	27.87	80°	77°	69°	.0968	6.05
12	60	18.75	2.1	70.66	20.37	76°	72°	69°	.0338	2.11
13	38	15.29	2.75	63.16	27.87	80°	74.5°	70°	.0663	3.96
14	19	12.28	1.65	63.16	27.67	79°	75°	71°	.0185	1.16
15	34	12.35	3.4	31.5	20.	79°	71.5°	69°	.1126	7.04
16	60	20.46	4.5	25.25	26.25	69°	66°	67°	.2270	14.19
17	41	15.80	4.3	25.25	26.25	70°	66°	67°	.2026	12.66
18	22	12.52	3.74	25.25	26.25	70°	66.5°	67°	.1439	8.99
19	60	22.13	5	20.25	31.25	72°	67.5°	69°	.2954	18.46
20	27	15.22	4.5	20.25	31.25	72°	68°	69°	.2270	14.19
21	22	14.52	4.4	20.25	31.25	72°	67°	69°	.2146	13.42
22	60	23.12	5.4	15.25	36.25	74°	67°	68.5°	.3593	22.45
23	30	17.46	5.2	15.25	36.25	73°	69°	69°	.3259	20.37
24	19	16.2	4.72	15.25	36.25	73°	69°	69°	.2531	15.82
25	60	17.05	2.8	36	15.5	74°	69.5°	69.5°	.0693	4.33
26	34	10.17	2.3	36	15.5	74°	70°	70°	.0424	2.65
27	18	7.46	1.25	36	15.5	73°	70°	70°	.0093	.58
28	60	15.87	1.5	41	10.5	76°	72°	70°	.0146	.92
30	60	31.66	4.1	75.78	55	82°	70°	108°	.1799	11.24
31	60	31.66	2.9	75.78	55	84°	71°	110°	.1691	10.57
32	28	25.28	4.1	75.78	55	84°	71°	114°	.0757	4.73
33	60	31.66	4.1	75.8	55	81°	70°	116°	.1799	11.24
34	60	31.28	4.1	75.8	55	80°	70°	82°	.1796	11.24

FIG. 20-21.

IMENTS WITH AIR LIFT PUMP.

11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
Weight of Water Pumped per Sec. Lbs.	Quantity of Water Pumped in 24 h'rs. Gallons.	Work per Sec. of Pumping the Water. Foot Lbs.	Air at 75° Fah. Compressed per Second. Cubic Ft.	Work of Compressing Air per Second. Foot Lbs.	Resistance in Water Pipe. Foot Lbs.	Resistance of 3 Bends in Air Pipe. Foot Lbs.	Resistance of 3 Bends in Air Pipe. Foot Lbs.	Resistance of 5/8 in. Nozzle in Air Pipe. Foot Lbs.	Resistance of Circular Bend in Water Pipe. Ft. Lbs.	Resistance Due Velocity of Discharge. Foot Lbs.	Sums of Work of Pumping & Resistances as Determined. Foot Lbs.	Efficiency of Pump. Per cent.
11.25	116,576	850	1.086	2616	832	652	80	88	8	63	2583	33
9.3	96,4	703	.878	1864	481	325	39	38	5	37	1628	38
5.15	53,495	389	.552	1180	159	155	19	14	1	13	1050	33
20.37	281,578	724	1.086	2569	1050	458	80	88	15	58	2473	28
19.41	201,204	690	.846	1842	570	400	48	48	10	68	1834	37
14.99	155,39	533	.552	1155	325	155	19	14	4	33	1083	46
12.3	99,662	437	.405	834	160	97	11	11	2	18	736	52.4
9.61	60,329	526	1.104	2269	631	580	89	86	9	12	1933	23
5.82	37,325	318	.644	1072	118	190	29	28	2	14	699	30
3.6	62,726	196	.405	636	36	77	11	11	5	4	340	31
6.05	21,902	382	1.104	2046	137	281	89	86	2	44	1021	19
2.11	42,962	149	1.104	1851	401	514	89	86	6	15	1260	8
3.96	11,988	250	.669	1051	106	194	35	34	2	12	633	24
1.16	72,965	70	.350	450	8	54	8	8	0	1	147	16
7.04	147,696	222	.616	795	80	137	28	28	2	15	508	28
14.19	131,285	358	1.104	2039	618	495	89	86	15	115	1775	18
12.66	98,247	320	.754	1175	280	230	41	39	7	52	969	27
8.99	93,286	226	.405	528	66	65	11	11	1	12	392	43
18.46	147,296	374	1.104	2147	832	537	89	86	20	152	2090	17
14.19	139,061	287	.497	748	167	110	18	17	4	32	635	37
13.42	232,826	272	.405	589	118	71	11	11	3	22	507	46
22.45	211,183	342	1.104	2209	926	582	89	86	25	141	2091	16
20.37	164,01	311	.552	911	352	111	19	14	10	66	883	34
15.82	44,906	241	.350	550	133	59	8	8	3	25	477	44
4.33	27,475	156	1.104	1800	182	398	89	86	5	34	950	9
2.65	6,026	93	.616	880	37	123	28	26	1	7	315	11
.58	9,461	21	.331	288	2	36	7	7	0	14	73	7
.92	116,575	38	1.104	1712	38	360	89	86	1	7	619	2
11.24	109,577	852	1.104	2685	836	674	89	86	9	65	2611	32
10.57	44,054	801	1.104	2685	792	674	89	86	9	70	2521	30
4.73	49,554	359	.515	1091	92	161	19	18	1	7	719	33
11.24	116,575	852	1.104	2685	836	674	89	86	9	65	2611	32
11.24	116,575	851	1.104	2666	836	674	89	86	9	65	2610	32

FIG. 20-21.

cent., as with the other examples, and this area will be 3.04; 3.04-8 degrees=38 per cent., and if reheating be used to 300 degrees and the exhaust be cooled off before returning to compressor, the efficiency will be 50 per cent., almost double the efficiency of the ordinary direct acting air pump. If now we look at diagram No. 2, where we compress from 90 to 180 and exhaust at 90, we have an efficiency of 50 degrees cold, which would be increased by 7-5 if reheated to 300 degrees, or 70 per cent. These percentages are probably marred by frictions and leakages which I have no means of ascertaining, but I should judge these could be kept within 10 or 15 per cent., making the simple pump show an efficiency of probably from 50 to 60 per cent., with compound compression.

These pumps can also be compounded with considerable gain, but it would easily form the subject for another paper. I wish to remark that I cannot understand why this system has not been pushed for compressed air station pumping. I believe it will be very satisfactory and economical, and some day will be extensively used. It has one advantage over the Harris system inasmuch as the back pressure is constant, and ordinary pumps may be operated with it. The principal objection is the high pressure and consequent leakage and the double set of pipes and joints. This system should be regarded with high favor.

AIR LIFT PUMPING.

While the air lift system of pumping has been brought recently to the attention of the public, it is not a new thing, there being records of its use more than 100 years ago.

The honor of putting the air lift system in practical shape is due to Dr. Julius Pohle, who came to San Francisco from Arizona, where he had been experimenting with several plants, one with a lift of 300 feet. Dr. Pohle established himself at the office of Rix & Firth, who interested themselves to the extent of expending considerable money in experiments to determine the efficiency of the system. A ten-inch well was sunk sixty feet deep on a piece of property belonging to the Mechanics' Institute, San Francisco. The bottom was cemented, a gallows frame 75 feet high was erected over it, and a tank and weir constructed over the well to measure the water flow. Air and discharge pipes were arranged so that many different ratios of lift and submersion could be tried. The compressor had a compound air cylinder, actuated by a Corliss engine of 50 horse power. The well known civil engineer Mr. B. M. Randall conducted the experiments, and they were made on August 27, 1899. The results showed efficiencies as high as 52 per cent. The records of this test were tabulated and I have reproduced them for this occasion, not only for the information the table contains, but as an interesting point in the history of air lift pumping, for it is the first record of results.

Messrs. Brown and Behr tested the experimental plant referred to, and in a paper read before this society in 1890, stated that the greatest efficiencies were

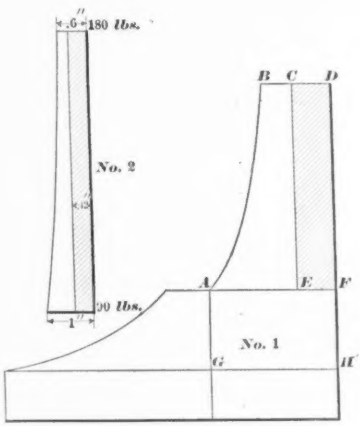


Diagram Illustrating the Cummings' System.

FIG. 22.

obtained when the submersion of the pipe was twice the lift, and at this an efficiency of 50 per cent. was obtained.

Quite extensive experiments have been made in Germany, to determine the efficiency of the air lift, and their results fall somewhat short of the percentages obtained in this country. The efficiency was the ratio of work in discharged water to the indicated compressor work, and ranges from 45 to 30 per cent., with

Head.	Quantity of Free Air.	Quantity of Water, Gallons.	Air P. in Receiving.	H. P. of Air.	H. P. of Work Performed.	Efficiency.	Submersion.	Ratio Air to Water.
39	170	750	37	20	8	40	60	1.7–1
30	150	400	20	11	3	27	45	–1
35	170	600	39	21	6	30	70	2.2–1
32	100	500	39	12	4	33	87	1.5–1
22	50	187	10	2	9	45	30	2

EXPERIMENT IN ARTESIAN AIR LIFT PUMPING.

Depth of Well.	Size of Casing.	Natural Flow.	Height to Raise Casing to Stop Flow.	Submersion.	Quantity of Free Air.	Air Pressure.	H. P. to Beneath Air.	Pumping Head.	Quantity of Water Pumped, Gallons.	H. P. in Water.	Efficiency.	Ratio Air to Water.
950	5 & 8	200	6′	180	135	73	24	33	1,300	11	46	.8–1
950	5 & 8	200	6′	110	135	41	165	30	800	6	36	1.3–1
950	5 & 8	200	6′	146	135	56	20	32	900	7	35	1.2–1
700	7	20	1	100	120	38	16	30	800	6	38	1.2–1.

FIG. 2[illegible].

TABLE FOR AIR LIFT PUMPING.

Dia. Air Cyl.	Stroke.	Cu. Ft. Free Air at 100 Revs.	Cu. Ft. Free Air at 125 Revs.	Suitable Pumping Heads.	Quantity Pumped at 100 Revs. in Gallons.	Quantity Pumped at 126 Revs.	H. P. Required 100 Revs.	H. P. Required 125 Revs.	Ratio of Submersion to Lift.
60 TO 100 LBS. PRESSURE.									
10	12	92	108	80–120	200–175	232–205	12–17	15–20	3–2
12	15	165	195	80–120	350–310	420–370	22–32	26–36	3–2
14	16	245	288	80–120	525–465	620–550	35–45	38–55	3–2
30 TO 60 LBS. PRESSURE.									
12	12	132	152	40–80	330–285	380–325	12–18	14–20	3–2
14	15	229	270	40–80	570–500	675–580	22–30	25–35	3–2
16	16	312	368	40–80	780–670	920–800	30–40	35–50	3–2
10 TO 30 LBS. PRESSURE.									
14	12	183	216	10–40	640– 450	850– 540	8–18	10–22	3–2
16	15	293	345	10–40	1000– 730	1200– 860	13–30	15–35	3–2
18	16	408	480	10–40	1400–1000	1700–1200	18–40	21–50	3–2

FIG. 24.

smooth pipes—a lift of 50 feet, and a submersion of from 4 to 3 to 3 to 2.

The amount of water discharged increases with the quantity as well as the pressure of air, but the efficiency falls away very rapidly when the output is forced. A submersion of 50 feet and a height of discharge of 25 feet, with increasing quantities of air, gave quantities of water from 4 cubic feet to 15 cubic feet per minute; the quantity of air varied from 7.6 to 105 cubic feet per minute, and the ratio of free air to the water lifted varied from 1.96 to 7.60 cubic feet of air to 1 cubic foot of water, the efficiency being in a like proportion.

In another set of experiments, with lifts from 43 to 230 feet, submersion from 92 to 400 feet, from 2.9 to 5 cubic feet of air was required per cubic foot of water pumped, and the pressures from 30 to 160 pounds. The quantity that can be handled is practically unlimited.

It is safe to calculate on velocities in the pipe from 4 to 8 feet per second, and it will take from 2 to 3 cubic feet of atmospheric air per cubic foot of water pumped for heights from 15 to 50 feet and from 50 feet to 100, I should figure, on from 3 to 4 cubic feet of air per cubic foot of water. I believe for very low heads the air consumption may be still further decreased and 1.5 cubic feet of air will lift a cubic foot of water 20 feet high.

"Engineering News," Vol. 37, Page 140, gives some interesting data on air lift pumping at Rockford, Ill. The pumping was done from 4 wells, 84 feet, 82.5 and 59 feet from surface to water while being pumped and 7½ additional into a tank, with an air pressure of 76 pounds per square inch. The wells were close together. A 2½-inch pipe led from the reservoir to each well, and a 1½-inch pipe was continued in the well casing, with 225 feet submersion. The discharge was 2,000,000 gallons per 24 hours. From the steam indicator diagrams, 124 horse power was used. The average yield was 1,401 gallons per minute, and the net work done was 24 horse power, or an efficiency of 20 per cent. A 14x22 duplex compressor made 96 revolutions to do the work. This would give about 600 cubic feet of free air. About 200 cubic feet of water was pumped, or 3 cubic feet to 1, a result which is average. The efficiency is low, because the compressor took too much power. In a compound compressor 600 cubic feet of air should be compressed to 76 pounds for an expenditure of not to exceed 100 horse power. This would make the efficiency about 25 per cent. The air pressure was excessive and was due no doubt to the small well casing, because with proper well pipes, 50 pounds air pressure would have been ample.

I have not yet succeeded in making any general rules for sizes and capacities for air lift pumping. There is generally a surprise waiting for you no matter what you do. There should be some particular relation of all the quantities concerned that will give the best results and yet for a considerable variation either way, in submersion, and air pressure, the quantity of water will remain the same. The relation between the diameter of the discharge pipe and the velocity of water seems to be a delicate one. I should think that 5 feet per second would establish a good proportion. The air pipe must be large enough to minimize the friction loss. The initial air pressure will of course be that due to the submersion, and will decrease after the discharge begins, until with a 3 to 2 submersion the pressure will correspond to a head of about one-half the submersion plus the lift. In flowing artesian wells, the best results seem to be obtained by giving deep submersion, small air quantity and high pressure.

Sand may be cleared from a well by filling the air reservoir with air at a high pressure, then suddenly releasing it, the air pipe having first been given quite a submersion. The sand comes out in masses and can be seen distinctly. In the illustration submitted herewith the column of water measured over 100 feet above the mouth of the well. It will be noted that about 20 feet above the mouth of the well there seems to be a general radiation in all directions from one center of the water sprays. It would seem that a bubble of compressed air had been carried up there and then suddenly expanded. The efficiency of the air lift will naturally increase directly in proportion to the temperature of the water.

The air lift has a special field of usefulness and will scarcely be given over to much competition with other pumps. When a large quantity of water must be brought out of a small casing, no other method would be so satisfactory. If an artesian well fails to deliver to the proper point by a few feet, no other system could make it deliver its water so efficiently.

AIR LIFT PUMPING.

For example, at Alvarado one of the large artesian wells refused by about two feet to flow into the general cachement basin; nothing could be done but to pump it, and it would have required a centrifugal pump capable of handling 1,000 gallons a minute to restore the required quantity. A one-inch compressed air pipe inserted 155 feet into the well, and consuming 6 horse power of compressed air, stimulated the well to complete action.

The plain open air pipe seems to be the best manner of ending the air pipe in the well and whether it point up or down is not material. Dividing the air into minute bubbles by fine perforations seems not to do as well as the open pipe. I have compounded the air lift into several lifts, one discharging into the other, with fair results, but it would be better to discharge each section into an open tank and let the water dispose of its air bubbles.

The greatest general efficiency of the system will become apparent under conditions where the number of wells that can be operated by an engine plant do not yield enough water without lowering the surface of the water too far. Let us say that normally the water stands at 20 feet from the ground, and in order to get the quantity from six wells they are lowered to 80 feet. By sinking perhaps six more wells some greater distance away, and air-lifting all twelve, the pumping may be done at a head of only 40 feet. This would be possible, of course, with pumps, but not practical. In general and within pumping limits of 120 feet, I shall conclude that from 50 to 60 per cent. efficiency is possible, but 30 to 40 will probably be nearer the average plant.

The tables, Fig. 23, are from actual experiments made last year, and the table, Fig. 24, gives some general requirements for air lift pumping which may prove useful.

MOTOR-OPERATED PUMPS.

This class consists of pumps belted or geared or direct connected to any kind of engine. There is no doubt that with Corliss engines, coupled directly to pumps, the mechanical efficiency is as high as 85 per cent. Let us take an example on this basis, using compound compression, and the engines being cross compound, and double reheated, to 300 feet, or 7-5 increase of volume. The comparison of curve areas, Fig. 25, shows that an efficiency of 88 per cent. should be obtained. This, it must be understood, is for a station pump, where all proportions are specially designed for the one object in view.

No account in any of my calculations is taken of reheating. The expense is small, and I should think might be taken as 5 per cent. of the economy, consequently this sum should be deducted from all of my reheating calculations. It costs practically the same to heat to 300 or 400 as to 200, provided the reheater is close to the motor, where it should be. The amount of air required by engines per horse power will vary from 25 to 5 per cent., according to the amount of reheating and amount of expansion used.

All admit that the loss in the compressed air problem is one of heat. The

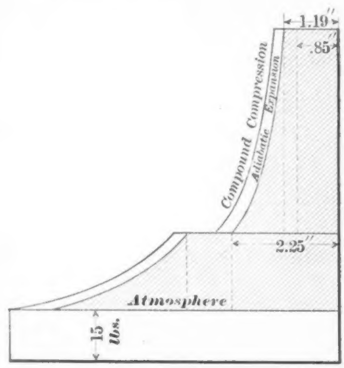


Diagram of Compound Double Reheated Air Motor for Pumping.

FIG. 25.

air is all there; none of it gets away. All admit that if this heat be restored and a sufficient quantity added to overcome leakage and clearance, we should get back our original expenditure, less, of course, the mechanical losses in the motor. Inasmuch as in compound compression to 90 pounds the temperatures need not ex-

ceed 225 degrees at any time, what is there to hinder our returning this and much more besides, when we have 500 degrees at our service? I have used 430 degrees in a Corliss motor with excellent results, and believe another 100 degrees could have been added. The whole question is one of temperature and the successful solution lies in special and intelligent adaptation of the forces at our service. Too many have condemned compressed air without a hearing, and I hope these remarks may stimulate some one to give special attention to the pump problem and give us some pumps worthy of the atmosphere which they now so generously use.

In conclusion, it may be stated that I do not wish to be understood as giving absolute values to the quantities mentioned in this paper. Others may find in their experience that I may have allowed too little or too much for mechanical efficiencies, or that I have assumed too high a standard pressure. This does not interfere with the comparative values of the various systems, which is the real point toward which I have desired to direct your attention.

RECAPITULATION

90 Lbs. Air Pressure on Main

Kind of Pump	Foot Gallons	Efficiency Simple C'mpress'n	Efficiency Compound
Direct Acting Simple	135	19	20
Direct Acting Simple 300 reheated	180	24	28
Direct Acting Compound Water reheated	232	32	375
Direct Acting Compound 1 Cylinder Heated 300	280	40	46
Direct Acting Compound 2 Cylinder Heated 300	326	46	53
Direct Acting Triple 3 Cylinder Heated 300	383	54	62
Direct Acting Triple 3 Cylinder Heated 400	444	63	72
Plain Displacement	175	22	25
Wheeler Displacement	34% for 34 lbs. pressure		
Multiple Displacement	320	40	46
Harris Displacement	60 to 70%		
Merrill Displacement	175	22	25
Cumming System	35 to 70%		
Compound Motor Pumps	50 to 80%		
Direct Acting Triple Water Heated	300	42	48
Pohle Air Lift	30 to 60% heads less than 200 feet		

Compressed Air Plant at Ainsworth.

The first drill ever run by compressed air derived direct from falling water, under the Taylor patents, was started in operation in April at the camp of Ainsworth, the plant having been installed by the Kootenai Air Supply Company of Nelson, B. C.

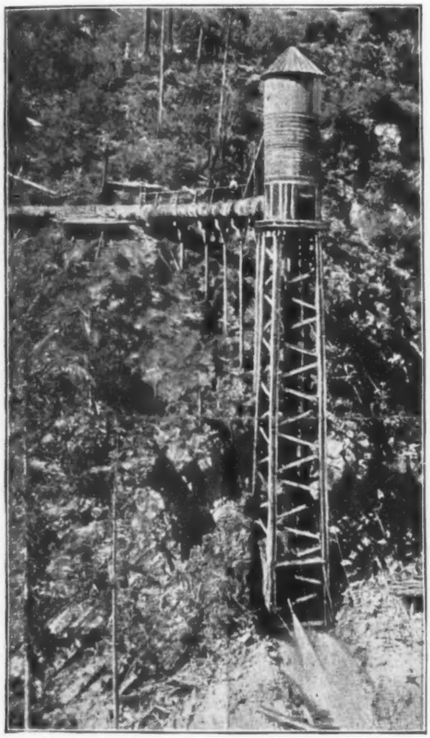
The plant is now completed, and the compressed air automatically made, is being distributed throughout the ramifications of the camp and in the great variety of uses in mining camp work it is of more than passing interest to the great army of mine owners to whom compressed air is the necessity of their daily business, and no one can go to Ainsworth and see the novel features of the installation there—the water collecting the free air from nature, carrying it into the bowels of the earth, and leaving it tightly boxed in a chamber compressed to 87 lbs. pressure ready for the drill, and passing on down the creek to find its tortuous way to the ocean—without being impressed with the simplicity and effectiveness of this great invention.

The whole process of converting the raw energy into manufactured power ready for delivery through the pipe lines, is absolutely automatic, with no machinery of any kind, and so long as the water comes from the flume the compressed air is being made.

DETAILS OF THE WATER POWER PLANT

The plant is located on Coffee Creek to the south of Ainsworth and about 2½ miles from the principal operating mines. The creek has a flow varying from 2,500 cubic feet per minute to several thousand, and the flume used is stave barrel construction, round steel bands being bolted around it every three feet. The flume is 1,350 feet in length, 5 feet diameter in the clear, the available head at the compressor being 107½ feet. The water at the compressor tower is received in a wooden tank 12 feet in diameter, height 20 feet; a downflow pipe passes from the water level through the bottom of this tank down perpendicularly and at the creek level a shaft was sunk 210 feet deep. The downflow pipe (which is 2 ft. 9 in. in diameter, outside measurement of stave pipe construction throughout, the stay bands being set from 6 inches to 3 feet

apart, dependent on the pressure to which the particular section is subjected) passes on down in the middle of this shaft, terminating in a great steel bell shaped chamber at the bottom. The down flow pipe discharges into a deep groove being open to the chamber in about its middle, the so-called groove being open to the chamber. The dimensions of this chamber are height 17 feet, diameter 17 feet, the bell shaped bottom



TOWER OF COMPRESSOR PLANT ON COFFEE CREEK, AINSWORTH DISTRICT.

standing about two feet from the bottom of the shaft, thus allowing the water to pass out. The discharge of the mingled water and air from the downflow pipe into this groove causes it to swirl around the whole circumference of the chamber, some 51 feet, giving the air an opportunity to leave the water and to rise into that portion of the chamber which is above the line of the channel, while the water drops below to the rock bottom of the shaft, and the water in the supply tank at the head rises in the shaft on the outside of the bell and the downflow pipe to the level of the creek. This back water column is an important factor in this system of compression; its weight on the falling water in the downflow producing the pressure, every 27½ inches of height of column of backwater increasing the pressure of air and water in the downflow pipe one pound: Thus, the shaft being 210 feet in depth, and the depth of the groove which is the effective back head, being 200 feet, the air pressure roughly will be 200 feet divided by 27½ inches, or 87 pounds, which the gauge on the compressor records. The air in the chamber has been isothermally compressed, the moisture has been absorbed from it by the water which surrounds each globule in its passage down, and it goes to its useful work three times dryer than the original air that was entrained cold and pure. A goose neck pipe reaches from the surface of the creek to the level of the dividing line between the air and water in the chamber, and whenever more air is being made than is being used, the air displaces the water, and the surplus passes out of this pipe. It is discharging into nature through the pipe at the foot of the trestle in the accompanying photograph; on the other hand, when more air is being drawn than is being made, a pressure valve on the surface of the ground shuts off the flow until the automatic air maker catches up to the demand. In other words, by this device the pressure cannot vary to exceed one pound, or 27½ inches of water column, and the compressor plant can be left alone to do its work perpetually.

THE AIR MAKER.

The accompanying sketch plan shows the elevation and plan of the tank at the head of the trestle, where the water is received from the flume and the air is entrained. The air maker is an inverted iron tanked funnel of the downflow pipe. It is seven feet in diameter, and arranged with a screw lift, so that the amount of water allowed down the downflow pipe can be regulated. Around the circum-

ference of this tank are inserted 3,000 pieces of ¾-inch gas-pipe, the upper orifice of which is open to the air, the lower

PIPE-LINE TAYLOR AIR COMPRESSOR PLANT AT AINSWORTH.

orifice being in the water, all of which must pass these lower orifices in rushing down the downflow pipe. The speed of the water in the downflow pipe is approximately 34½ feet per second, and the speed with which the air is drawn in with it will be nearly the same. The air is received by the water in millions of globules which retain their individuality, gradually becoming smaller in their passage down until finally liberated in the chamber below.

THE EFFECTIVE WORK OF THE PLANT AT THE COMPRESSOR.

The flume has a fall of 4 feet to the mile and the velocity of flow is figured at 3.72 feet per second, and the volume at 70 cubic feet per second. The actual effective head is 107½ feet and the available horse power allowing 75 per cent. efficiency is 620 H. P. The area of the downflow pipe being 4½ square feet and the area of the shaft 32 square feet. The speed of the water in the penstock or downflow pipe is 34½ feet per second. The amount of free air taken in under these conditions is 85 cubic feet per second, or 12 cubic of air compressed to 87 lbs. The motor air horse power will be 465. The efficiency of the plant will vary with flowage. At a later date complete data will be available under a variety of different conditions.

THE PIPE LINE.

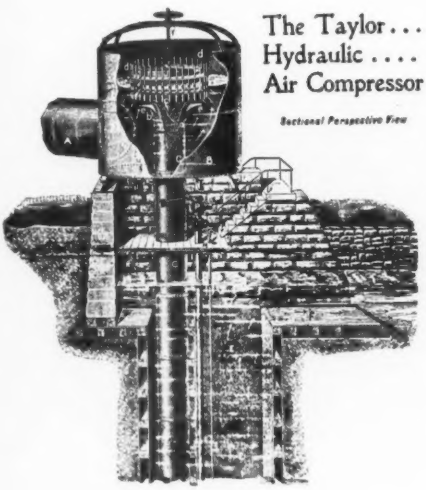
In all the construction a light lap welded pipe with screw joints has been used. The air leaves the compressor in a 9-inch pipe, branching some little distance out, one branch being left for later construction, the main branch running north parallel to the Kootenai Lake to the mines round Loon Lake. This branch is of the following dimensions: 6,200 feet of 7¼-inch pipe to the Dictator, 4,000 feet of 6¼-inch pipe along the west side of Loon Lake serving the Lady of the Lake and Mamie mines, and 1,100 feet of 5-inch pipe branch northeast to the Tariff, Highlander, and the big tunnel of the Philadelphia Mining Company. The total length of straight line is 11,300 feet. The properties reached by the pipe line at present are: The Eden, Crescent, Last Chance, Dictator, King Solomon, Krao, Lady of the Lake, Mamie, Little Donald, Black Diamond, Little Phil, Tariff, Highlander, Albion, Spokane and Trinket, and the intermediate claims.

The tunnel of the Philadelphia Mining Company is now in 700 feet and is being driven from the bench above the Stevenson concentrator to tap the various ledges of the camp. This tunnel will give a depth of 900 feet at the highest point of the hill; it has already intercepted the Tariff vein and drills supplied from the Taylor plant are driving the cross-cut tunnel ahead and drifting to the ore body on the Tariff ledge.

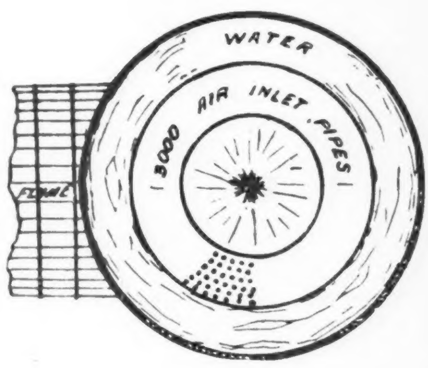
ITS USEFUL WORK.

Air was turned on to the pipe lines in the early part of April, and the first ma-

chine drill ever run by air direct from a column of water was started in the big tunnel of the Philadelphia Mining Company on the 16th of that month. Mr. E. E. Knowles, the mechanical engineer in charge of the plant, in writing of the plant, says:



"The machine drill first started was a ¾-inch Rand and is 12,000 feet from the compressor at Coffee Creek. It started without a hitch and with 85 pounds air pressure at the drill. This pressure is absolutely maintained at all times. I will venture the statement that there is not another machine in the world to-day working with as dry and pure air as this one, and I will also add that there is none giving better results. Manager Henry Stevenson, of the mining company above referred to, who is using the air, has expressed himself as being highly pleased with the air and the pressure at this distance from the compressor was a surprise to him. Here is an instance of what the capabilities of this system of compressing air will do. The company referred to has a developed water power with a working head of 1,000 feet, and are using a Pelton wheel belted to a mechanical compressor; yet this cheapest of plants to operate has been shut down for the simple reason that they are getting their power furnished them at their very door for just one-half what it was costing them for labor to run their plant, to say nothing of their investment, interest, oil and repairs. The compressor is running fine with not a soul nearer to it than three miles. At least it is presumed to be, as it is breathing into this machine drill at a rate that pleases the men who are running it and causes the muckers to get a hump on themselves." The work at the Philadelphia tunnel is in charge of Mr. Sherwin, and in conversation with him he made the statement that the effective work of the air could not be beat; after shooting a round of eight holes the men go back to work in from 15 to 20 minutes with the tunnel perfectly clear of impurities, and as clear as a bell in every way. Mr. Sherwin says that with all his experience with mechanical compressors, and some of them have had a capacity of 50 drills, he has never used air that is equal to the Ainsworth Air for clearing out smoke and impure air, and he also dwells on the fact that this air is an infinitely better power factor, inasmuch as it is always at constant pressure, and thereby the machine men are able to do better work and to break more ground. Mr. Stevenson, the gen-



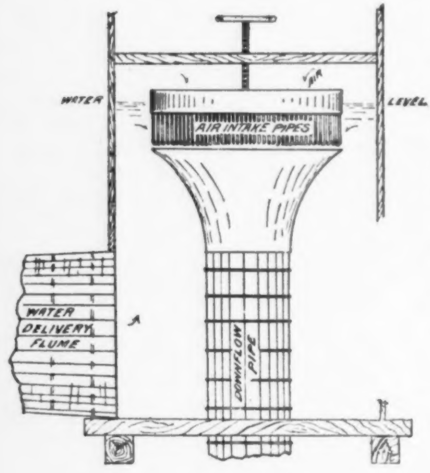
— PLAN —

eral manager of the company, is equally well pleased with the air.

THE COST OF THE PLANT.

The installation at Ainsworth has cost in the neighborhood of $60,000, including incorporation, water power development and pipe line. Of this investment $20,000 will cover the pipe line cost, $10,000 the water-power improvements, and $30,000 the compressor cost. The latter cost was especially heavy in Ainsworth by reason of the fact that the shaft was sunk in an unusually hard formation and involved a cost of nearly $50 per foot.

On the basis of a gross air power of 600 the output when 4,200 cubic feet per minute is used of the capacity of the water flume this would represent a cap-



— ELEVATION. —

ital investment of $100 per horse power, or upon a motor horse power of 465 (allowing loss in delivery and loss in engines) the capital cost per horse power would be 130.

The company is now selling the power delivered at the mines at $4 per drill, with a liberal reduction where more drills are used. The power is being used for pumping, hoisting, blacksmith forges and ventilation, the drill charge including ventilation.—The Mining Record.

The Pneumatic Caisson Foundations for the Broad-Exchange Building, New York City.

The Broad-Exchange Building, now under construction at the corner of Broad street and Exchange place, in New York City, will be the largest office building in the United States. It will be 23 stories, or 286 feet, high above the street and will cover an irregular area of about 27,000 square feet, with frontages of 236 feet on Exchange place and of 106 2-3 feet on Broad street, and with a wing about 100 feet long and 35 feet wide extending south toward Beaver street. The exact dimensions of the ground plan are shown by Fig. 1. Altogether there will be 10,000 tons of steel employed in the framework, which will be inclosed with walls of granite to the top of the first story, of Indiana limestone to the top of the third story, and of brick and terra cotta for the remainder of the height. The framework will be carried by 100 lines of columns, each founded on a separate steel caisson sunk either to bedrock or to the hardpan overlying it. The large number of caissons which were sunk and the extreme celerity with which, under the conditions, this work was done, make the foundation construction of particular interest, and we present here a description of the apparatus and methods of work employed.

PRELIMINARY WORK.

The foundation work of the Broad-Exchange Building is of interest, not so much for its character, which was not particularly novel, as it is for its extent and for the difficulties which resulted from the short time available for carrying it out. To make these matters clear it is necessary to set forth the actual conditions in some detail.

The Broad-Exchange Building is being built for a syndicate of New York capitalists, the general contractors being the George A. Fuller Co., of New York City. The contract called for the completion of the building ready for the tenants by May 1, 1901. On May 1, 1900, the work was placed in the hands of Clinton & Russell, of New York City, as architects, and of Purdy & Henderson, of New York City, as structural engineers. So far as actual construction

was concerned, therefore, the condition of affairs was that not a line of the plans had been placed on paper twelve months previous to the day set for the tenants to move into the building. Evidently the utmost haste was imperative. Furthermore, it must be remembered that this haste was necessary at a time when the rush of work had placed all of the large steel mills behindhand with their orders, and that large quantities of steel work were the first materials needed for the beginning of construction.

The problem was a twofold one; plans had to be prepared in a remarkably short time, and the methods had to be devised to secure the manufactured materials to put these plans into material form in the building. Under ordinary conditions the engineers would have waited until the architects had settled upon at least the general lay-out of the building before beginning work, but to follow this precedent in this instance would have necessitated a delay which, although it was short, neither they nor the architects were disposed to endure patiently. Accordingly the engineering studies were begun without knowing at all what the final plans of the architects would be. It is obvious that these studies had to be in a great measure of a tentative character.

The first act was to adopt a tentative plan calling for 106 lines of columns, and to estimate and assume the column loads. This work gave something of a definite basis upon which to begin studies of a foundation plan. The general contractors had had in mind using pile foundations, but before adopting this construction it was decided to make a comparative study of several types of construction. The next work, therefore, was to design and to estimate the costs and relative advantages of pile foundations, foundations consisting of steel cylinders filled with concrete, and of foundations consisting of pneumatic steel caissons filled with concrete. As the result of these comparative studies a report was presented on May 23, in which the use of pneumatic caisson foundations was advised. The decision was accepted by the gen-

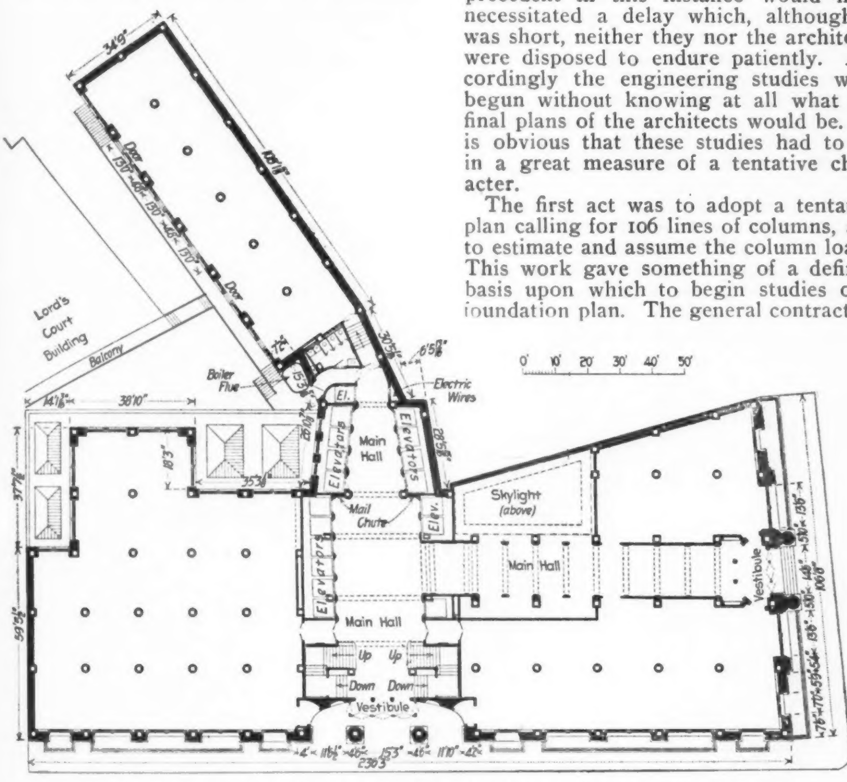


FIG. 1—FIRST FLOOR PLAN OF BROAD EXCHANGE BUILDING, NEW YORK CITY.

eral contractors and, stated briefly, was influenced by the following considerations:

(1) By using pneumatic caissons comparatively certain results in the time required for the work were ensured. Some of the material penetrated was exceedingly unstable; it was quite certain that pneumatic caissons could be sunk through this material without danger of unforeseen delays, but there was no such certainty if either of the other forms of construction were adopted. (2) By using pneumatic caissons the good character of the foundation work could be ensured beyond a doubt, and this was not possible if either of the other constructions was employed. (3) The reputation of pneumatic caisson foundations for excellence was considered to be a material advantage to the builders and owners from a business standpoint. There was also

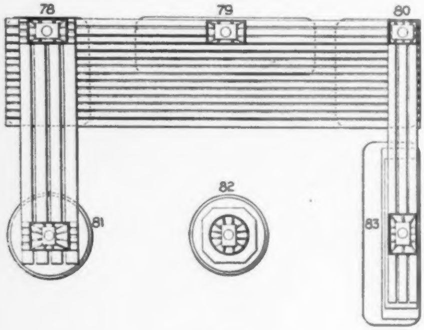


FIG. 3.
SKETCH PLAN OF EQUALIZING GIRDER SYSTEM FOR COLUMNS 78, 79 AND 80.

another consideration which influenced the selection of pneumatic caissons, and this was that whatever style of foundation might be adopted for the other columns, those coming on the party lines would have to be founded on pneumatic caissons in order to prevent disturbing the foundations of the adjacent buildings.

With the consent of the general contractors to the use of pneumatic caisson foundations one factor of the problem has been disposed of. By this time the architects had determined in a general way the lay-out of the building, and it was possible to decide approximately upon the number of columns to be employed. It was not possible, however, to locate these columns definitely, and hence their exact loading could not be calculated. From the data available, however, two things were certain: (1) that the number of columns to be provided with foundations would be at least 100, and (2) that the loads on these columns would run between a certain maximum and minimum. Obviously, therefore, if a typical caisson should be designed which could be made in a number of sizes between those required for the known maximum and minimum loads, it would be possible to order a number of each size in advance of definite knowledge where each was to be located, and yet with the certainty that they could all be used somewhere. There was very little risk in such a mode of procedure, and the gain in time of manufacture which it made possible was an important advantage.

The column caissons were, therefore, divided into two classes. The first class comprised the caissons for the wall columns on the party lines, which required special design in each instance, and could not, therefore, be designed until the location and loading of the columns which they were to carry were definitely known. The second class comprised all but a few of the columns not coming on party lines, and for which a typical general design of caisson was possible. The typical design of caisson adopted was a cylindrical caisson of steel; the diameters were fixed at 7, 7½, 8, 8½, 9 and 9½ feet. The next step was to secure some one who would manufacture these steel caissons quickly. To obtain immediate manufacture and delivery by any of the large steel works was found to be out of the question, and a search was begun among the smaller concerns capable of handling the work. This search proved unusually successful. A contract was made with the Lukens Rolling Mill Co., of Coatesville, Pa., to roll the steel sheets in three days, and with the Coatesville Boiler Works to begin the delivery of the caisson in ten days from the date that the steel sheets were delivered to them, provided they were furnished the I-beam bracing, which they could not manufacture, at once and in shape ready for use. To secure the I-beam bracing the engineers went to a number of places where a small lot could be obtained, and to ensure

its prompt delivery to the Coatesville Boiler Co. a man was sent on the car with every lot to prevent any hold-up of the shipment by the railways.

Shortly after the order for the manufacture of the caissons had been given, the architects presented a definite plan of the building. This plan enabled the engineers to begin the definite design of the steel work, and the plans were far enough advanced by the time the first delivery of caissons was made to enable them to be located at once, and the sinking begun. Before describing the work of sinking the caissons, the general character of the foundation construction and the details of the caisson construction will be described and illustrated.

GENERAL PLAN OF FOUNDATIONS.

The foundations were designed upon the general plan that each line of columns should have its individual caisson foundation. All the caissons except those located along a portion of the south and west party lines are cylindrical and carry the column footings concentric with their top. The party wall caissons are rectangular with their longer sides parallel to the party-line. As will be seen the cylindrical caissons vary from 7 feet to 9½ feet in diameter, the greater number being of the smaller size. They are filled with concrete to the top, and most of them also have a granite capping the full size of the caisson. The column bases are circular in plan and are bolted directly to the caisson masonry.

In the case of the rectangular caissons the column loads are distributed to the masonry by means of I-beam grillages, as shown by the various sectional elevations. The most complicated of these distributing girder systems is that for the group of columns at the south end of the wing, an enlarged plan of which is shown by Fig. 3. The two bays or panels between columns Nos. 78, 79 and 80, have a system of wind bracing consisting of X-braces of channels.

CAISSON CONSTRUCTION.

Details of the caisson are shown by Figs. 4 and 5. Fig. 4 shows one of the 7-foot cylindrical caissons, but the construction of those of larger diameter is practically the same. Fig. 5 shows one of the rectangular caissons; the others, except one, No. 98, which is of trapizoidal form, are exactly like this except in dimensions. All the caissons were built of medium steel 5-16 inch thick for the caisson proper and ¼ inch thick for the cofferdam portion. The caissons all have reinforced cutting edges and a working chamber 6 feet 6 inches high. The minor details of construction are clearly shown by the drawings.

METHODS OF WORK.

Borings made at ten different points over the foundation area showed first a layer of filling from 2 feet to 6 feet thick overlying a layer of fine sand or fine sand and clay mixed, which extended to hard-pan at an average depth of about 40 feet below the street surface. The fine sand and clay mixed proved to be a very unstable material; when wet it ran almost as freely as water. The hard-pan was, however, of the firmest and most stable character, being practically a rock, and directly below it came the gneiss bedrock. Upon the showing made by the borings general instructions were drawn for the sinking of the caissons, which were, somewhat condensed, as follows:

If the hard-pan over the rock is not more than 6 feet deep, the shaft should be open to the bottom and cleaned out, so that the concrete shall have a perfect bearing on the clean rock. If the rock is not more than about 1 foot out of level and the hard-pan is about 2 feet thick or more, the concrete can be placed directly on the rock. If the hard-pan is thin or there is none, and the face of the rock is generally even, it must be leveled off or cut or shaped in some way so that it will resist any tendency to lateral displacement. If the rock is very uneven it must be leveled off or channeled or fixed in some good way to afford a satisfactory footing for the concrete shaft, not only for the direct load it must carry, but also to resist any tendency to lateral displacement.

If rock is not found after the excavation has been carried fully 4 feet into good hard-pan, drive a crowbar, in not less than two places, to locate the rock. If it is found within 2 feet, excavate out the hard-pan to a secure bearing on the rock. If it is not found, clean out a footing on the hard-pan over an area somewhat larger on all sides than the size of

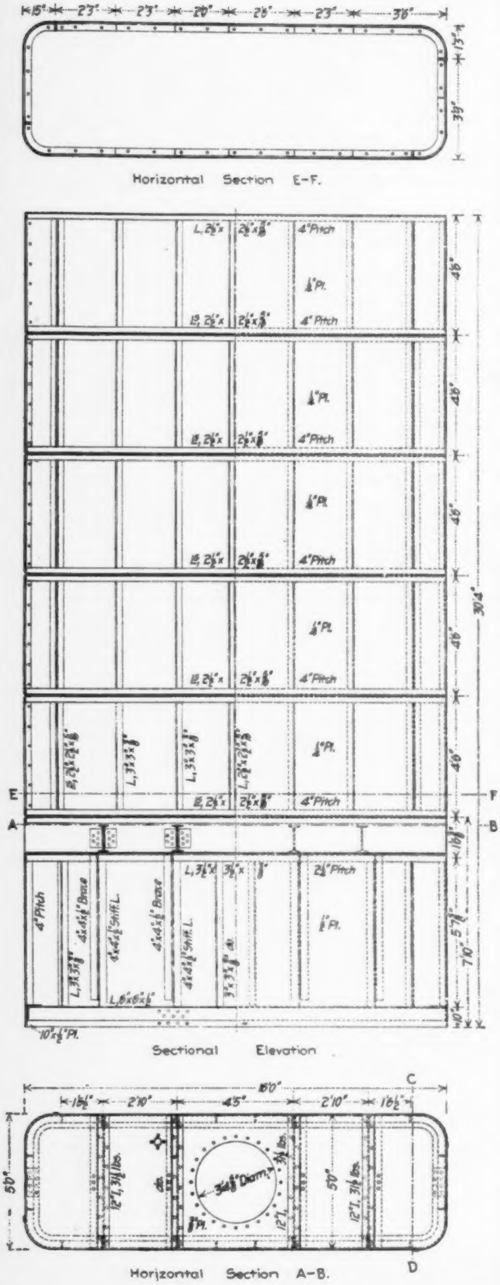


FIG. 4

the cutting edge of the caisson, as given in the schedule below:

7-foot diameter must be excavated 8 inches more, all sides.

7½-foot diameter must be excavated 18 inches more, all sides.

8-foot diameter must be excavated 9 inches more, all sides.

8½-foot diameter must be excavated 10 inches more, all sides.

9-foot diameter must be excavated 11 inches more, all sides.

9½-foot diameter must be excavated 12 inches more, all sides.

By this schedule of arrangement the bearing area of the caisson masonry was increased from 39 per cent. for the 7½-foot caissons to 49 per cent. for the 9½-foot caissons.

The contract for the pneumatic work in sinking the caissons was awarded to the Engineering Contract Co., of New York City. The general contractors located the caissons, set them up ready for sinking, furnished the concrete, and supplied the derricks and hoisting machinery; the Engineering Contract Co. furnished the compressed air, the steam power and the labor, and sunk the caissons and placed the concrete under pressure. The concreting in the open was done by the general contractors. The engineers checked the location of the caissons and watched that they were kept plumb. Their engineer in charge also went into each caisson to see that the excavation had been properly finished and also supervised the placing of the concrete. With this brief explanation of the apportionment of the work, it will be described as a single task to avoid confusion.

The bottom of the foundation excavation was about 15 feet below the street surface, and at the level of the street surface a strong timber platform was built covering the whole area. The caissons and all structural material for the foundations were unloaded onto this platform and it also carried the power plant and machinery. Chutes, stairways and traps at various points in the platform allowed the materials to be sent below as they were needed.

The air compressor plant for the caisson work consisted of two 16-24 × 12-18-inch Ingersoll-Sergeant air compressors, supplied with steam by a 4-inch pipe from the mains of the New York Steam Co. These compressors delivered into a

6 × 18-foot cylindrical receiver. To cool the compressed air for delivery to the caissons two methods were employed. When at the beginning of the work no more than four caissons were being sunk at once, it was found possible to keep the air below 80 degrees F. by pumping cold water through the receiver. At a later stage of the work when as many as ten caissons were under way at once, an additional cooling device was employed which consisted of 54 pipes ¾-inch in diameter contained in an 18-inch × 15-foot cylinder. The air from the compressors was passed through the pipes and cold water was kept in constant circulation through the cylinder. From the cooling cylinder the air passed into the receiver at a temperature of about 70 degrees F.

For the first five or six feet of their descent or to water level the excavation inside the caissons was done in the open, and then air pressure was put on. As the sinking progressed the cofferdam of the caisson was added to so as to be always above water level, and was filled with concrete around the central air shaft. The maximum air pressure used was 18 lbs. Generally the weight of the concrete in the cofferdam and a load of ten or twelve tons of pig iron were sufficient to sink the caissons. The caisson men worked in three shifts of eight hours each, and there were nine gangs of six men in each shift. Each gang had three men in the working chamber, one man in the air lock and two outside. Air pressure was maintained at 30 lbs. in the receiver and was throttled down to the required pressure at each caisson.

All the caissons were provided with 36-inch shafts, which in the majority of cases were divided diametrically by two inside angle guides. The bucket used was semicircular in plan and worked up and down in one compartment of the shaft while the other compartment contained a ladder and served as a main shaft. In other cases a cylindrical bucket 18 inches in diameter was employed.

At first the concrete was mixed on the main platform near the caisson in which it was to be used. Later on two small platforms were built at central points about 10 feet or 12 feet above the main platform, and each of them was equipped with a balanced wheelbarrow-elevator running to the bottom of the main excavation. The cement, sand and broken

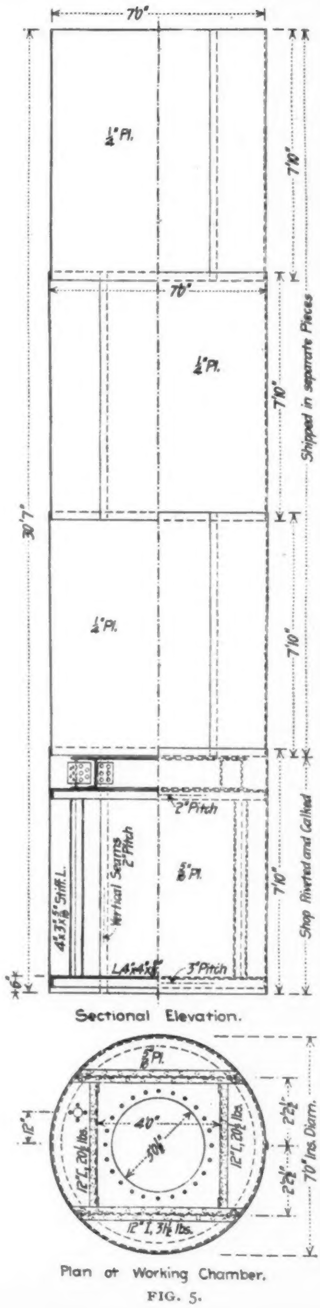


FIG. 5.

stone were hoisted to the upper platform and mixed by hand. The mixture was then shoveled into a gravity mixer which discharged onto the floor of the main platform. From the point of discharge the concrete was taken by wheelbarrows to the caissons. Pressure was maintained in the working chamber until the concrete was set, and then the air lock was removed and the cofferdam was filled and the capstone placed. The final work was the placing of the column pedestals.

In conclusion it should be noted that 88 caissons were sunk in 47 days. The most rapid sinking recorded was 2 feet in one hour and 27 feet in 20 hours.

Pneumatic Tools.

The Pneumatic Tools now being manufactured and put on the market by the Philadelphia Pneumatic Tool Co., of Philadelphia, have many important and novel features.

Taking up the several kinds of tools made by them in the order of their importance and wide range of work for which they are adapted, we have first the Chipping and Calking Hammers.

These hammers are made in five sizes, the smallest being designed for light chipping and calking, and the largest for the heaviest kind of work, such as chipping steel castings, cutting off gates, sink heads, etc.

These hammers are all of the "valve" type.

There are only two moving parts in the hammer, the hammer proper and the valve, both moving in the same direction at the same time, so that the jar caused by the hammer striking a blow tends to more firmly seat the valve and not to move it from its seat. This insures uniform working of the hammer even after it has been worn after years of service.

The material used is of the very best and the valve hardened and carefully ground and fitted.

For riveting two sizes of hammers are made, the smallest one driving 5-8-inch hot rivets and under, and the largest, or Long-Stroke Hammer, driving 1 1-8 inch hot rivets. The design and construction of the valves of these hammers is the same as in the Chipping Hammers, thus avoiding the irregularity of action due to the wearing of the valve.

The Long Stroke Hammer, by an ingenious arrangement, ceases to operate as soon as the die is lifted from the rivet, although the throttle valve may be open; this avoids any unnecessary wear or liability to breakage which may occur should the hammer operate when the die is not held against some object. Other important changes and improvements have been made.

ROTARY DRILLS.

Probably the most trying work on Pneumatic Tools is the drilling, reaming and tapping of holes in boiler, bridge and car shops. The work is rushed through by unskilled workmen, and the tool, to do it successfully, must be carefully designed strongly built and simple in construction. These features have been embodied in the drills made by this company and are the result of years of experience in their design and manufacture. They are built for the hardest service, but at the same time are finished with a high grade of machine work equal to the other work done by this company. The drills have improved piston blades, fitted with packing strips that require no attention to keep them tight. These are so made that as the machine is used the bore of the cylinder acquires a glassy polish similar to that found in steam engine cylinders. For convenience in tapping, flue rolling, etc., these drills are made reversible.

FOUNDRY RAMMERS.

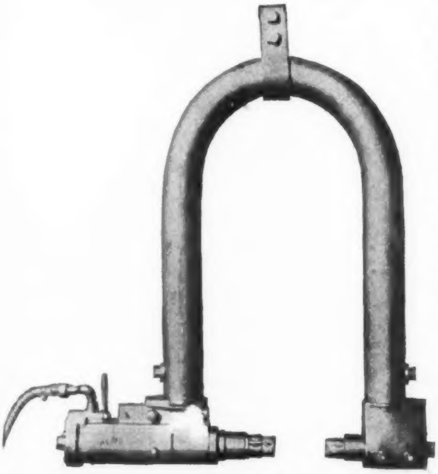
One of the important steps recently made by this company in introducing labor-saving tools has been the introduction of their Foundry Rammers. With this tool one man can do the work of four or five men besides ram up a flask much more evenly, and thus reduce the risk of bad castings or increased weight from straining to a minimum. At present they are making the rammers in three sizes; the No. 7 or Light Hand Rammers, the No. 8 or Heavy Hand Rammer, and the No. 9 or Crane Rammer, to be used suspended from a crane.

The No. 7 Rammer is designed for flask work, and ramming in limited space where a large rammer cannot be used. The No. 8 is especially built for

loam work and ramming up very large flasks.

The advantages of these rammers are as follows: They strike a uniform blow, work at a uniform rate, one man with a No. 8 Rammer can do the work of six or eight men, and with a No. 9 Rammer the work of from twelve to fifteen men and do it better, more evenly and harder.

Where these rammers are in use they have paid for themselves in a short time, and many duplicate orders have resulted They are now in use in some of the largest foundries in the country.



YOKE RIVETER.

The Pneumatic Riveting Machine illustrated above is adapted to a wide range of work on tanks, stacks, bridges, ship framing, structural work, etc. It will drive rivets of any size up to 1 1-8-inch, and may be used with any depth of yoke, from 10 inches to 10 feet or more.

The Riveter itself presents many improvements in design. It is absolutely positive in its action, no dependence being placed on springs or other similar devices. The entire action of the machine is under the control of the operator by means of one throttle lever shown in the illustration. The first movement of the lever causes the hammer cylinder to move out against the rivet; the next movement starts the hammer to work upon the rivet. When the rivet head is completed a reverse movement of the lever causes the hammer to stop working and the cylinder to withdraw into the casing by air pressure. The advantage of this arrangement is that the cylinder may be moved out until the button set comes in contact with the hot rivet and held there while any necessary adjustments are made before starting the hammer to work. This will, in many cases, prevent spoiling the rivet and necessitating cutting it out. The withdrawal of the cylinder into its casing by means of air pressure enables the operator to use the machine in any position with the certainty that the cylinder will positively remain inside the casing until he is ready to drive the next rivet. These points will be appreciated by those who use machinery of this kind.

The machine is light in weight and simple in construction, having but three moving parts. It is fully guaranteed as to efficiency and durability. With each machine we furnish two riveter dies and one holder on die with necessary collars for adjusting the gap for different lengths of rivets. The machine requires 25 cu. ft. of free air per minute for operation and ample facilities are provided for thoroughly oiling all parts. Users of this class of machinery will find this Pneumatic Yoke Riveter to be a first class machine, unequaled in material, workmanship and efficiency.

On field work, erecting large water, gas and oil tanks, 80 to 100 rivets per hour have been driven.

Pneumatic Furnace Door Hoists at Parkgate.

At the Parkgate Iron and Steel Works an effective method of lifting or lowering the doors of the open-hearth furnace by compressed air is in use.

The air is compressed by a Westinghouse pump fixed on to the wall of the power station building. This pump is shown in Fig. 1; besides operating the hoists for the furnace doors it also works some pneumatic tools, and the feed motion of the hot saw. It gives air at 80 lbs. pressure. This form of pump has for some years been employed on locomotives in connection with the Westinghouse Brake with the most satisfactory results, there being over 30,000 in use for this purpose alone. Owing to their small

size, their compactness, portability, and the readiness with which they may be fixed to a post or wall by means of four bolts only, they are very suitable where space is the chief consideration. In mining work, being self-contained, they may be lowered down shafts and suspended by a chain; and, having no dead point, they may be started and stopped from a long distance. The consideration of

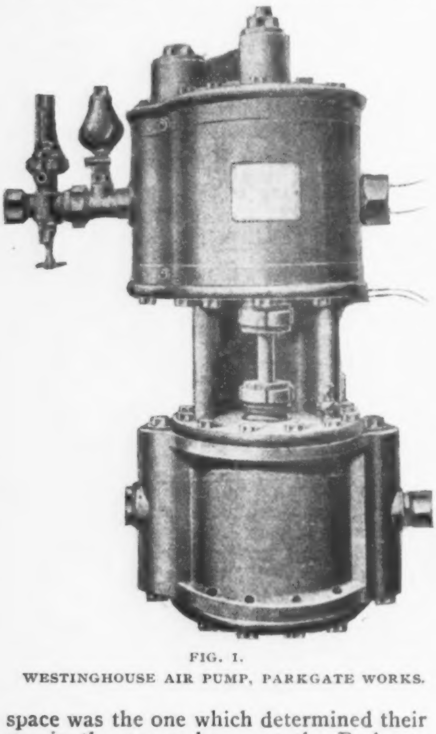


FIG. 1.
WESTINGHOUSE AIR PUMP, PARKGATE WORKS.

space was the one which determined their use in the power house at the Parkgate Works. The Westinghouse type of pump is of so familiar a design that we will not take up space in describing it. We may remark, however, that the valves of the air cylinder are of the ordinary description. Each upward stroke admits air below the piston, and discharges air from above the piston; and each downward stroke does the reverse. The valves may be easily removed and examined. The lift of the discharge valves does not exceed 1-32 inch. The pumps have 10-inch air and 10-inch steam cylinders.

The air hoists used at the furnace are

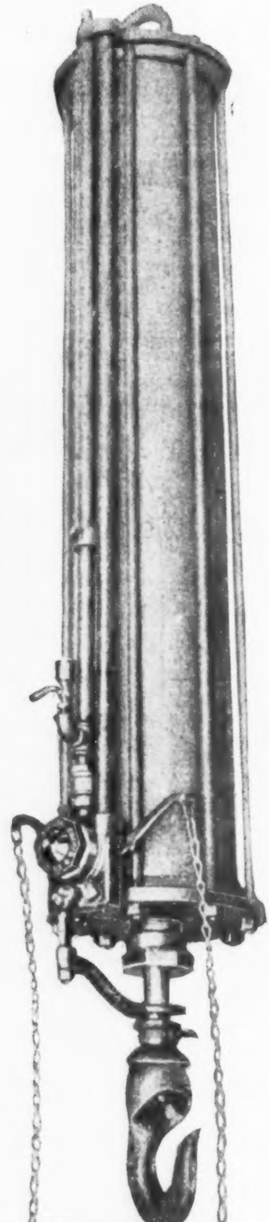


FIG. 2.—VERTICAL PNEUMATIC HOIST.

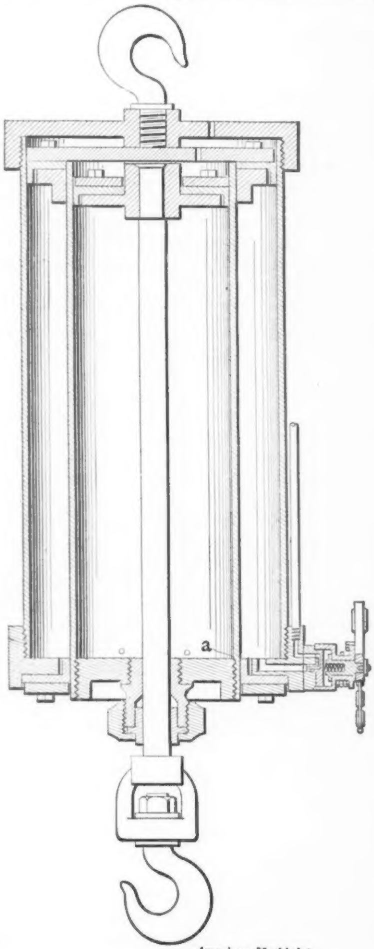
of the vertical type, and were furnished by the United States Metallic Packing Company, of Bradford. The hoists are 5 inches diameter and 4 feet stroke, having a lifting capacity at 80 lbs. air pressure of 1,410 lbs. With this size of hoist, 3½ cubic feet of air at 80 lbs. is required to lift the maximum load, 4 feet. The hoists have self-closing valves, safety check, oiling device, automatic stop, and ball and socket hook. The cylinders are made of special steel tube. The valve is self-closing by means of a spring, as soon as the hand chains are released. An adjustable stop is attached to the piston-rod, so that the load may always be stopped at the same point if desired. A safety check is fitted so that the load cannot fall in case of the breakage of air hose while hoisting.

Speed adjustment is provided to govern rate of hoisting or lowering. These hoists are made with a standard lift of 4 feet. The air hoists at Parkgate are provided with balance to take the weight of the furnace door, so that the hoist has only to overcome the difference.

A Telescopic Air Lift.

The cut shows a recently patented air hoist which may be found serviceable in some special situations where a considerable vertical lift is required with only a limited space in which to move. A specially designed valve is used in connection with the hoist, but this it is not necessary to describe, as any valve may be used which will admit compressed air from the service pipe for hoisting and discharge to the atmosphere for lowering, accordingly as the valve is moved in one direction or the other.

As will be seen, the arrangement consists of one cylinder moving within another, with a piston in the inside one and a rod passing down through a central stuffing box for hoisting. Obviously more cylinders, one within the other, might be used if a greater vertical travel was required. The cut shows both the inner cylinder and the piston within it at the upper limit of their travel, and sustained in that position, we may assume, by a pressure of air. The area enclosed between the inside of the outer cylinder and the outside of the inner cylinder is somewhat greater than the internal area of the inner cylinder, so that in hoisting the inner cylinder will always be hoisted to the top before the piston within it begins to rise. In low-



American Machinist

A TELESCOPIC AIR LIFT.

ering, this movement is reversed, the piston first descending and then the cylinder. This is necessary because there is no air passage to or from the interior of the inner cylinder except when it is up, and then holes (a) at the bottom are uncovered. With the parts in the position shown, if the valve is gently opened and the air permitted to escape slowly from

the outer chamber, it will also pass out from under the piston, and the piston will descend, and when the piston reaches the bottom its cylinder will then begin to descend, if the discharge of air continues. For hoisting, as there must be no pressure above to resist the pressure below, vent holes are provided in the upper heads of both cylinders. Leather packing is used at the top against the inner surface of the outer cylinder and at the bottom against the outer surface of the inner cylinder, and also for the piston inside the small cylinder. The inventors are Charles O. Bulock and Bertram C. Donnelly, Milwaukee, Wis.

Automatic or Direct Air-Brakes for Street Railways.

With the advent of heavy cars of the double truck type, air brakes are coming into very general favor, but on roads operating with trail cars they have for a long time past been very successfully used. In this latter case, particularly where the cars run over grades of any moment, some engineers contend that the so-called automatic system, such as is in very general use on steam railroads, should be applied to street railways, even where but one trail car is used. As in this system the breaking away of the trail car automatically applies the brake, it is quite natural that engineers should advocate its use, but a close study of the question will show that the conditions of service on street and steam railways are very different, and what is an excellent device on the latter has many serious drawbacks when used on the former in trains of two or three cars.

In the direct air system the pressure stored in the main reservoir is admitted directly to the brake cylinder pipe, the application of the brakes on a two or three car train being practically instantaneous when we open wide the valve on the motor car connecting this pipe to the reservoir. Now if we also run a pipe from the main reservoir, on the motor car, through to a reservoir on the trailer, and on the latter put a cock between the reservoir and train pipes, the conductor by opening it can apply the brakes, in case of necessity, as well as it is done in the automatic system. Again, if the couplings between the cars are provided with check valves which are pressed open when the two halves are connected, and close instantly when pulled apart, should a trailer break away from its motor car, it will have a supply of air at main reservoir pressure in its own reservoir, and the conductor, upon feeling his car take a retrograde movement, can open his valve and apply the brakes. This valve may be operated by a cord running the length of the car, so he has only to raise his hand to put on the full power of the brake, and this device is all that would be necessary on 99 roads in a hundred. If, however, an automatic device is insisted upon, as it might be in the one hundredth case, another cock, placed at the end of the trail car, with its handle connected by a chain to the motor car, would be opened upon the breaking off of the trailer, and apply the brakes as quickly as the "automatic air" system.

Therefore, it should be a simple matter for a street railway manager to decide whether or not he will equip his cars with a device which takes the direct control of his power brake out of the motorman's hands, and thereby jeopardizes every one of about a million stops, for the sake of moving by air a valve that will automatically apply the brakes in case of the trailer breaking away, when equally safe results may be obtained by a valve operated by the conductor or mechanically, but which leaves the operation of the brake directly in the hands of the motorman, thereby making it absolutely certain to act when he moves his hand, to say nothing of the smoother and better service thereby obtained.

Furthermore, the improved automatic couplers and heavy safety chains used to-day reduce to a minimum the liability of a trailer breaking away from its train, and thus, for this class of service, rob the automatic system of its peculiar charm. In view of the magnificent service performed by the Automatic system on steam railroads, no one could deny its value in this field, but on street railways it is a "white elephant," pretty in theory but bad in practice. E. H. Dewson.

Notes.

A. F. Hollis has just completed for Erven Geeck a compressed air system used for sterilizing faces, one of the latest things used in barbering.

The Chicago Pneumatic Tool Co. has purchased the plant and business of the Great Western Pneumatic Tool Co. in Denver, Col., and will manufacture the Schmucker drill and air compressors at the Denver shops, of which C. H. Skinner is manager.

The Standard Anti-Friction Equipment Company, 50 Broadway, New York City, are erecting a frame factory building, 50×150 feet, at Wilkesbarre, Pa., where they intend moving their Amesbury, Mass., plant as soon as it is completed. They will build pneumatic gears, the same as were formerly built by the Amesbury Pneumatic Gear Co.

The Westinghouse Airbrake Company has just closed a contract with the Pennsylvania Railroad Company to furnish 5,400 sets of the new Westinghouse friction draft gear. The contract is worth, approximately, $200,000, and is in addition to that secured from the Baltimore and Ohio Railroad Company some time ago for 7,000 sets of the gear.

The "Gollmar" Bell Ringer, manufactured by the United States Metallic Packing Co., of Philadelphia, Pa., is a very simple device for ringing locomotive bells. It has no moving parts outside except a rod. It is easily applied, uses little air, and can be used with steam as well as air.

It will not freeze up, and has an automatic attachment for ringing the bell every time the whistle blows.

It will last a lifetime.

Following is a test showing amount of free air per minute which will blow through thirty 3-32-inch holes into the atmosphere:

Gauge Pressure.	Cubic feet free air.
10 lbs.	99,696
20 "	149.544
30 "	199.392
40 "	249.240
50 "	299,088
60 "	353.090
70 "	407.092
80 "	456,940
90 "	510,942

The holes were drilled in a piece of 3½-inch pipe.

The air, before passing through the pipe, was cooled to atmosphere or normal temperature. Volumes can be taken as cold air. The amount of air which will blow through one 3-32-inch hole can be taken as 1-30 of the above volumes.

Compressed air, liquid air, liquid oxygen and ice are to be manufactured in Chicago this summer by the General Pneumatic Company, incorporated at Springfield, Illinois, with a capital stock of $25,000. The incorporators were Peter F. Thede, who is president of the company, Frederick Gedm and Thomas P. Kerrigan. Mr. Kerrigan, who is assistant superintendent of station "U" in the postoffice service, said:

"I know little of what the objects of the company are further than stated in the papers of incorporation. Mr. Thede, who lives at 4547 Lowe avenue, has some inventions that we believe to be good things along the liquid-air line, and a number of us have joined together to help him start his project just as soon as he can get his patents perfected. It will be several months, however, before we undertake to accomplish anything."

An interesting catalogue has been received from the Cleveland Pneumatic Tool Company of Cleveland, Ohio, describing their pneumatic hammers, drills, riveters, &c. Their No. X chipping, calking and beading hammer has a stroke of 1¾ inches at an estimated speed of 3,000 strokes per minute, and is used for light calking and beading locomotive flues and for chipping light castings. It consumes about 20 feet of free air per minute. Their No. O hammer weighs 11 pounds, has a 5-inch stroke at an estimated speed of 1,800 strokes per minute. It is intended for use on very heavy chipping and can be successfully used for riveting up to ⅝-inch hot rivets. The Cleveland piston air drills are for drilling, reaming, tapping and screwing in stay bolts and general work. No. A will drill in cast iron up to 2 inches and in steel up to 1⅝ inches. All of these appliances, which are made in a wide line of sizes, are extremely simple in construction, reliable in operation and not liable to get out of order.

The latest application of pneumatic power to iron work is the continuous pneumatic forge. This tool is a self-feeding forge for heating rivets, and employs fuel oil as the heating medium, compressed air being employed in an air-blast for the oil-heated furnace. This

is a hopper which holds a keg of rivets, and mechanism whereby the rivets are fed automatically into the heating chamber, where they are brought to the proper temperature by means of the combined air and oil blast. This arrangement enables from half a dozen to a dozen rivets to be kept at the proper riveting temperature all the time, doing away with the necessity of a heater boy. The air-blast is capable of regulation so that the rivets can be brought to the proper temperature without burning, and at the proper number per minute delivered to suit the requirements of the operator. As one rivet is removed, another falls down from the hopper and is gradually brought up to the riveting temperature. Provision is also made for using different sized rivets.

The Chicago Compressed Air Company, a subcompany of the Compressed Air Company of New York, is being brought out with the object of placing on the streets of the city motors propelled and heated by compressed air. The Board of Directors of the new corporation has not as yet been fully selected, but among those who will serve are Thomas H. Wickes, vice-president of the Pullman Company; J. C. Shaffer, Marvin A. Farr, Newell C. Knight and Sylvester T. Smith.

While no public offerings of the stock are being made it is being placed at $30 a share and the company will have a capital stock of $1,000,000 fully paid up. The local company will not manufacture its motors but will buy them from the parent company, which is now building motors at the rate of three a day.

The new motors are the same as have been in operation as night cars by the Union Traction Company. Twenty cars of a similar pattern are owned by the Metropolitan Street Car Company of New York.

The liquid-air automobile, which has attracted considerable attention recently, has one serious and almost fatal disadvantage as a practical apparatus, even after its ability to run is established, as now seems to be the case. Its motive power will not keep. When the liquid-air tank has been filled the machine must be kept in continuous operation, or an absolute loss of energy results through the evaporation of the liquid air without doing any work in the engine. In other words, its fuel cannot be stowed. Every time a new charge is required a recourse must be had to a central plant. This latter is also true of the electric automobile, and is one of its serious disadvantages; but it is much less serious than in the case of liquid air, because of the number of uses to which electricity has already been put and the resulting universality of electric generating stations. The time may possibly be not far distant when liquid-air plants will be so general as to largely remove the seriousness of this objection, and it may eventually be possible to so thermally isolate liquid air that it can be practically stored, but neither of these conditions at present exists.

Air in its passage through pipes is subject to friction in the same manner as water or any other liquid. The pressure at the compressor must be greater than at the point of consumption in order to overcome the resistance of the pipe. The power which is needed to produce the extra pressure, representing the resistance of the pipe, is lost, as there can be no useful return for it. The losses by friction may be serious if the piping system be poorly designed, and on the other hand extravagant expenditure in pipe may result from a timid overrating of the evils of friction. The difference in pressure between the entrance to the pipe and the point of use is, in hydraulic engineering, termed the loss of head, and the power lost—in hydraulics—is directly in the ratio which this loss of head bears to the entire head. The same line of figuring is sometimes applied to pneumatics. Friction of air in a properly designed pipe system is not a serious matter, and can be made as small as the most exacting requirements may demand. To reduce pipe friction the pipes must be enlarged, and, as this means additional expense, it is advisable to have a careful plotting made of the entire plant to see what may be true economy.

We illustrate a new form of flexible metallic tubing which has recently been imported from England. Flexible tubing as a substitute for rubber hose has long been the dream of those who use portable steam and air machinery. A great many designs have been made and experiments conducted on a large scale, but nothing has sufficed. The tubing shown in the

illustration warrants serious consideration, as it has been used for a number of years, subject to serious tests, and its construction is such as to promise suc-

cess. It is made of metallic tube rolled up in the form of a spiral, the edges overlapping, and fitted into each other tightly without affecting their power of motion. The tubing is sold by Messrs. Sharp, Klumph & Sisson, 1104-5 Monadnock Block, Chicago, Ill.

Railway men as well as others will feel interested in a barrel made of pressed steel, for they shortly will begin to notice oil coming to them in this receptacle instead of in the wooden barrel which in the past has been almost universally used for other than bulk shipments.

It seems odd, when one comes to think of it, that recourse has not been had before to pressed steel for a barrel, since shapes much more difficult to press are seen on the market in great quantities. It will be remembered that the storage tanks of the compressed air street cars now running in New York and Chicago are composed of seamless rolled or drawn steel bottles which are charged to 2,000 lbs. per square inch. These bottles are to be had of varying diameters up to 24 ft. in length. Hydraulic piping is now often drawn and joined in lengths by welding bands. Of course, there are in service a great many metal oil tanks constructed after the manner of the auxiliary reservoirs used on the brake system. But as the protection of these consists solely in a couple of encircling iron bands, these tanks are not as strong as they should be, and their shape makes them somewhat difficult to handle; also they are rather expensive. In consequence, the wooden barrel is still holding its own in oil shipments to a very great extent. Aside from the structural weaknesses of the wooden barrel, it is poorly adapted for shipping many acids and gases, while volatile oils and liquids are subject to considerable loss through evaporation in course of shipment.

It appears that the relations of pressure to distance in the forcing of water do not apply in the case of air, especially for long distances, although for short distances they may be taken as similar. Thus, if a certain head of pressure be required to maintain an air current of a given volume and force through 1,000 feet, twice the head would not be sufficient for 2,000 feet. This is because of the increase in volume due to reduction in pressure, or loss of head, by the time the end of the first 1,000 feet has been reached. Consequently a greater pressure must be used to counteract this increased volume, in addition to the extra head required to maintain the force of the current beyond. The bulk of the pressure, however, is lost by leakage and by the bands and elbows of the tube, especially when the latter have too small a radius, the resistance or retarding effect increasing in some at present unknown proportion as the radius of the curve diminishes. In one case the loss of pressure, including leakage, was only 2 lbs. of the initial 60 lbs. required to transmit 875 cubic feet of air per minute through an 8-inch pipe 7,150 feet long. In another case, the driving of the Jeddo tunnel, at Ebervale, Pa., the loss was only 0.002 lb. in transmitting air through a 6-inch tube a maximum distance of 10,800 feet, to drive two 3¼-inch drills. The volume of air required, however, for this purpose, 230 cubic feet per minute, was in small proportion to the size of the tube used. By careful consideration the transmission losses may be reduced to a minimum.—(R. Peel, Mine and Minerals, Pennsylvania, Vol. XX.)

A pressure regulator for compressed air receivers acts on a butterfly valve arranged inside the pipe that leads steam to the compressor engine, consists essentially of a small vertical cylinder with solid piston, the motion of which governs that of the valve. A three-way cock permits either of admitting compressed air

from the receiver under the piston or of affording free communication with the atmosphere. When air from the receiver is admitted under the piston, if the pressure should increase the piston will rise and gradually close the valve; thus progressively throttling the steam and consequently reducing the speed of the compressor. Moreover, the piston's motion cannot be irregular, because in proportion as it rises it will raise a series of heavy discs one after the other, the weight of which is regulated according to the mean pressure that it may be desired to maintain. When the pressure exceeds the highest limit fixed, the third and last disc will be raised; and then the valve will close the steam pipe almost completely so that the compressor will only turn very slowly.

According to the method of M. Naissant, the recipient of a gold medal, water is injected automatically into the valve-chest of the compressor for preventing the congelation that might be caused by the expansion and exhaust. The water injected is taken from the delivery pipe of a force pump, being thus introduced at a sufficient pressure for working the appliance; and a small cylinder receives this water, sometimes on one side and sometimes on the other of the piston, by the automatic action either of a cock or of a slide-valve worked by the engine. At the same time the side of the piston opposite that at which the water arrives is put into communication with the compressor valve-chest by means of similar mechanism, the over-pressure of the water working the piston so as to determine an emptying of the cylinders, while during the next and reverse stroke the same effect is produced but in the contrary direction, and so on. Two set-screws limit the piston's stroke in the injection cylinder, permitting the volume of water injected at each stroke to be regulated as desired; and with this appliance congelation is entirely prevented in a pump the air admission into which may be reduced to one-third.

The day of the chimney-sweep is past, say the Chicago inventors of a device for the cleaning of furnace pipes and sooty chimneys. Compressed air is the medium used in driving dirt and refuse from long used pipes and flues.

In a test given at the old Carter Harrison house, now occupied by T. S. Bergey, West Jackson and Ashland Boulevards, the machine cleaned many pipes of the dusty accumulation of years without producing a visible speck of dust in the rooms.

The machine, which is mounted on a wagon, consists of a five-horse power gasoline engine, which runs an air compressor of 200 pounds capacity, although a greater pressure than seventy-five pounds is seldom necessary to produce the desired result. The work is all done with a hose at the top of the pipes, and the machine works automatically.

An airtight cover is placed upon the top of a flue or over a register in a room. A hose is then inserted in a central valve and the air injected in short blasts. All dirt, dust and refuse, such as burnt matches, apple cores, lint and soot are driven from the pipes to the bottom of the furnace in the basement.

The invention is expected to prove a boon to those who appreciate pure air in their houses. The majority of houses and flats in Chicago are heated by hot-air furnaces. Pipes are placed in partitions and have many curves and crooks where refuse lodges. Many fires have been traced to such deposits.

The pipes become choked so that the hot air is prevented from circulating readily and dust is forced from the pipes covering furniture and carpets.

A saving in coal is one of the advantages promised, as clogged pipes are conceded to necessitate the use of more fuel than clean ones.

Mr. Bergey said of the invention:

"We have been unable to heat our house, and have time and again employed men to clean the pipes, but until to-day we had no idea of the amount of refuse that had collected. Nearly two barrels of stuff were precipitated into the furnace by the air blasts, and after its removal continued applications of the air pressure failed to produce a particle of dust."

The invention is being pushed by W. T. Van Dorn, who has an office in the Monadnock Building. He will place a sufficient number of machines around the city in the spring to meet all demands for furnace cleaning. The present time is late in the season for introducing the invention, as cold weather prevents the putting out of furnace fires.

COMMUNICATIONS.

Under this heading will be published inquiries addressed to the Editor of COMPRESSED AIR. We wish to encourage our readers in the practice of making inquiries and expressing opinions.

We request that the rules governing such correspondence will be observed, viz., all communications should be written on one side of the paper only; they should be short and to the point.

Chicago, January 1, 1901.

On and after this day the business of the Q. & C. Company and the Railroad Supply Company will be operated as one company, under the name of The Railroad Supply Company, with D. S. Wegg as chairman of the board, and C. F. Quincy as president.

The Railroad Supply Company,
By D. S. Wegg, President.

Q. & C. Company,
By C. F. Quincy, President.

General Office Bedford Building, Chicago, Ills. New York Office, 106 Liberty street.

U. S. PATENTS GRANTED DEC., 1900

Specially prepared for COMPRESSED AIR.

662,993. PNEUMATIC HAMMER. Daniel S. Waugh, Marion, Ohio. Filed Nov. 15, 1899. Serial No. 737,105.

663,001. SELF - HEALING PNEUMATIC TIRE. Edward Arthur, London, England. Filed Dec. 18, 1899. Serial No. 740,-792.

663,110. AIR-BRAKE COUPLING. Benson Vaughn, New Castle, Pa. Filed Feb. 10, 1900. Serial No. 4,837.

663,118. PNEUMATIC PIANO-PLAYING ACTION. James W. Crooks, Boston, Mass., assignor, by direct and mesne assignments, to said Crooks, and Ernest M. Skinner and Winchester Veazie, trustees, same place. Filed May 16, 1900. Serial No. 16,919.

663,150. PNEUMATIC STRAW-STACKER. George F. Conner, Port Huron, Mich. Filed Feb. 14, 1899. Serial No. 705,469.

663,236. AIR - BRAKE - INSTRUCTION CHART AND APPARATUS. Peter Lofy and Harry C. Ettinger, Springfield, Ill. Filed Jan. 18, 1900. Serial No. 1,863.

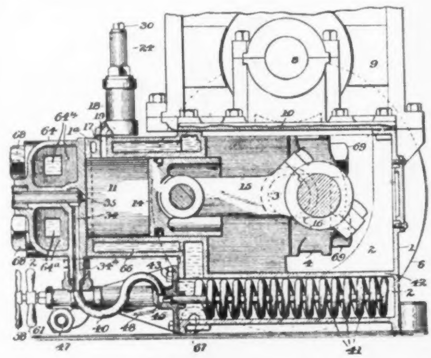
663,500. GAS OR AIR COMPRESSOR OR PUMP. James Keith, London, England. Filed Dec. 30, 1899. Serial No. 742,104.

663,633. PNEUMATIC TIRE. Frank H. Mason, Akron, Ohio. Filed March 9, 1900. Serial No. 7,975.

663,731. APPARATUS FOR PRODUCING COLD AIR FOR REFRIGERATING OR LIKE PURPOSES. Thomas Cole and William L. Cole, London, England. Filed July 9, 1900. Serial No. 23,019.

663,862. HIGH PRESSURE FLUID COMPRESSOR. Niels A. Christensen, Milwaukee, Wis. Filed September 9, 1899. Serial No. 729,957.

A compressor comprising a cylinder having a valve-governed discharge-port and a suction-port, a suction-valve governing

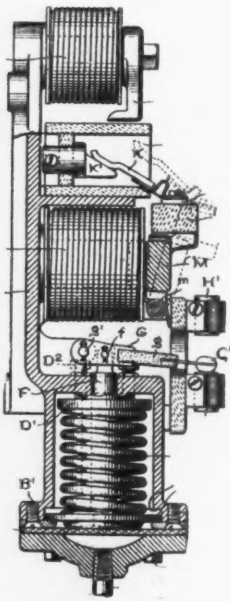


the suction-port and consisting of a casing provided with a chamber having a passage communicating with the suction-port and also having an air-inlet and an exhaust-port, a suction-valve governing the communication between the inlet and said passage to the suction-port and movable in said chamber but not fitting air-tight, a valve normally closing the exhaust-port against ordinary pressure, a casing for said last-named valve, a spring holding the same to its seat and means for adjusting the tension of the spring.

664,086. REGULATOR FOR ELECTRICALLY-ACTUATED AIR - COMPRESSORS. Edward M. Hewlett, Schenectady, N. Y., assignor to the General Electric Company, of New York. Filed Nov. 7, 1898. Serial No. 695,669.

The combination of a switch of moderate or small capacity with a shunt of large current capacity around its terminals, a contact corresponding to the inferior-pressure limit of a fluid-pressure system, which closes the motor-circuit through the switch, a relay device operated by the closing of the circuit for closing the shunt, a pressure-responsive device for opening the circuit at the switch as the pressure rises, thus leaving the shunt the only path to the motor, and means in circuit with other point of the switch corresponding to the superior-pressure limit, for opening the shunt when the switch makes the latter contact.

The combination of a two-point switch, an electromagnet in circuit with one point of the switch, a shunt around the switch opened and closed by the action of the electromagnet, a lead from one of the contacts of the shunt to an intermediate point



of the electromagnet-winding, and leads from the other point of the switch and its moving contact to the ends of the electromagnet-winding; whereby when the switch touches one point, a shunt is closed around its own contacts by the action of the magnet, and when it touches the other point, the magnet-coil acts differentially to de-energize the magnet and open the circuit.

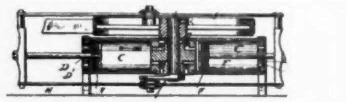
664,115. PNEUMATIC TRACK-SANDER FOR LOCOMOTIVES. Joshua B. Barnes, Springfield, Ill. Filed Aug. 9, 1900. Serial No. 26,410.

664,150. MACHINE FOR AERATING LIQUIDS. William Hill, London, England. Filed July 23, 1900. Serial No. 24,562.

664,184. PNEUMATIC-CUSHIONED SEAT-POST FOR BICYCLES. Jacob W. Stoll, Chicago, Ill. Filed Aug. 24, 1898. Renewed July 23, 1900. Serial No. 24,595.

664,230. AIR-COMPRESSOR. Harry M. Salyer, New York, N. Y. Filed Sept. 22, 1899. Serial No. 731,349.

An air-compressor, the combination with a central block having an externally-threaded neck on each side, cylinders having their inner ends threaded and screwed on said necks, pistons in the cylinder pis-

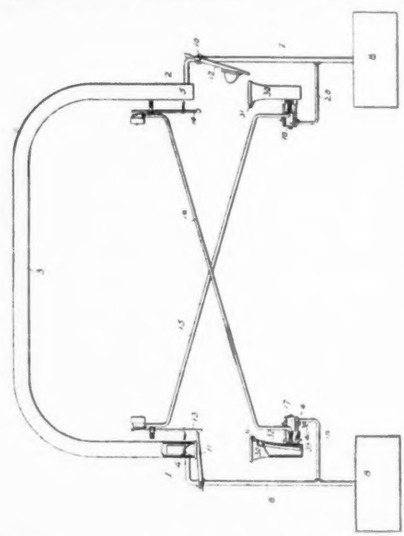


ton-rods, a central shaft passing through the boss, means for rotating said central shaft, means for operating the piston-rods from the central shaft, a channel in the top of the central block, outlet-ports extending from said channel to the inner end of each cylinder, an outwardly-opening valve in each port, an inlet-port extending from the inner end of each cylinder to the outer air, an inwardly-opening valve in each inlet-port and means for conducting compressed air from the said channel.

664,444. PNEUMATIC SPRING OR CUSHION. Sheldon H. Stubbs, Manchester, England. Filed Aug. 27, 1900. Serial No. 28,237.

664,547. PNEUMATIC DESPATCH CARRIER SYSTEM. James M. Hestor, Pittsburg, Pa. Filed April 10, 1900. Serial No. 12,332.

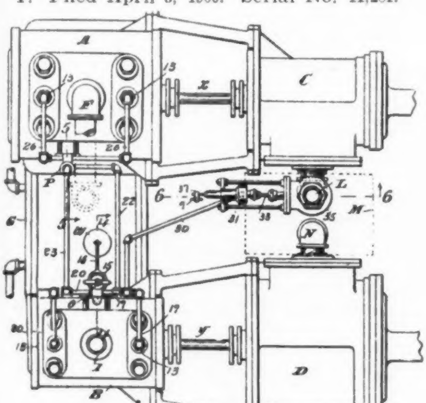
In a pneumatic-despatch carrier the combination of two stations, a transmitting-



pipe conecting them, receiving-chambers at said stations, gates for closing the same, releasing mechanisms for the gates, a source of air-pressure connected with the receiving-chambers, branch pipes extending from each station to the releasing

mechanism of the other station, valves controlling the admission of pressure to said branch pipes, direct connections between the source of pressure and the controlling-valves independent of the branch pipes, receiving casings for the carriers independent of the transmitting-tubes, movable members in said receiving-casings, and means for maintaining the engagement of the carriers with said movable members to prolong the opening of the valves.

664,562. UNLOADING MEANS FOR AIR-COMPRESSORS. Geo. de Laval, Cambridge, and George P. Aborn, Boston, Mass., assignors to the George F. Blake Manufacturing Company, New York, N. Y. Filed April 3, 1900. Serial No. 11,281.

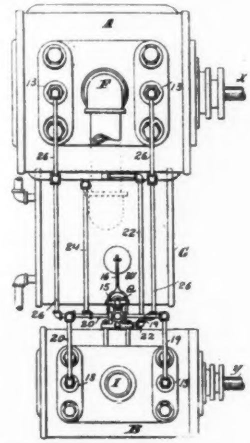


A multiple-stage compressor, the combination with cylinders operating at different pressures, of a valve controlled by the final pressure, and means controlled by the movement of said valve for unloading the pistons of the different cylinders.

Multiple stage compressor, the combination with high and low pressure cylinders having discharge-valves subjected to fluid-pressure tending to close the valves and arranged to remain open for the circulation of fluid between opposite ends of the compressor-cylinders when said fluid-pressure is relieved, of a valve controlled by the final-receiver pressure, and means controlled by the movement of said valve for applying and releasing the fluid-pressure on the backs of the discharge-valves of both cylinders for loading and unloading the cylinder-pistons, including an unloading-valve for the low-pressure cylinder actuated by the receiver-pressure of the low-pressure cylinder.

664,563. UNLOADING MEANS FOR AIR-COMPRESSORS. Geo. de Laval, Cambridge, and George P. Aborn, Boston, Mass., assignors to the George F. Blake Manufacturing Company, New York, N. Y. Filed Apr. 3, 1900. Serial No. 11,282.

A multiple-stage compressor, the combination with cylinders operating at different pressure, of means for unloading the pistons including an unloading-valve controlled by the final-receiver pressure and controlling unloading-ports for the different cylinders.



The combination with a compressor-cylinder, of a plunger-valve controlling unloading-ports for said cylinder and subjected to fluid pressures tending to move the valve in opposite directions, and a plunger-valve controlled by the receiver pressure and controlling the pressure of the first-mentioned valve for loading and unloading the piston.

664,596. PNEUMATIC RIVETING APPARATUS. Joseph J. Tynan and Henry C. Mostiller, Philadelphia, Pa., assignors, by mesne assignments, to the Pneumatic Tool Improvement Company, same place and Camden, N. J. Filed Nov. 6, 1899. Serial No. 735,899.

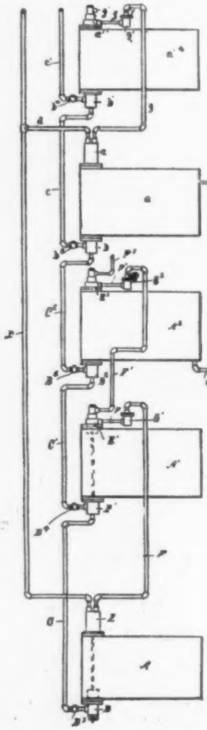
664,695. APPLIANCE FOR SUPPLYING AIR TO FURNACES. John Vicars, Sr., and John Vicars, Jr., Liverpool, England. Filed March 14, 1900. Serial No. 8,603.

664,699. AIR-VALVE. Thomas Wheatley, Syracuse, N. Y. Filed April 21, 1899. Serial No. 713,868.

664,723. APPARATUS FOR ACTUATING LIQUID WITH COMPRESSED GAS. Rudolph Conrader, Erie, Pa. Filed Aug. 28, 1899. Serial No. 728,718.

An apparatus for actuating liquid with compressed gas, the combination of two pump-chambers arranged to bring the liquid to be actuated and the actuating-gas into contact within said chambers; a connection leading from one of said chambers to a source of gas-supply; an independent gas connection between said chambers; means for admitting a liquid to each of said chambers; means for conducting an actuated liquid from said chambers; and automatically-actuated valve mechanism for controlling the movement of compressed gas, arranged to open the connection to the gas-supply during a closure of the connection between said chambers, and to govern the connection between said chambers so as to main-

tain an opening between them during a closure of the connection to the source of



gas-supply, and during the emptying of the liquid from the second of said chambers.

664,766. ARMORED PNEUMATIC TIRE. Albert H. Lewis, Midvale, Ohio, assignor, by direct and mesne asignments, of three-fourths to Samuel Brannan, Charles Valot, and John A. Newport, Somerdale, Ohio. Filed Sept. 20, 1900. Serial No. 30,-596.

664,776. APPARATUS FOR COOLING AND AGITATING AIR. Edwin F. Porter, Boston, Mass., assignor to the Bay State Electric Heat and Light Company, Jersey City, N. J. Filed Dec. 20, 1897. Serial No. 662,541.

664,816. PNEUMATIC SHUTTLE AND PICKER - STAFF BUFFER FOR LOOMS. Francis A. Mills, Methuen, Mass., asignor of one-half to Grosvenor B. Emmons, same place. Filed April 19, 1900. Serial No. 13,496.

664,824. COLD-AIR PRESSURE APPARATUS FOR BEER OR OTHER FLUIDS. Gottlieb Schmidt, Philadelphia, Pa., assignor, by direct and mesne assignments, to Harry E. Bell and Emma Schmidt, same place. Filed Dec. 30, 1897. Renewed Oct. 30, 1900. Serial No. 34,963.